ume 18 Number 4

The Welding Engineer

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Pioneer Business and Technical Journal of the Welding Industry

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ded Cargo Vessel
liam F. Kenny
(See Page 27)

April · 1933

Now!

MUREX
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WELDING

AN EASIER, QUICKER METHOD OF JOINING HEAVY PLATES

DRASTICALLY REDUCES WELDING COSTS—AND DOES A BETTER JOB

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Compared with ordinary methods, where a Vee is employed, Straight Gap welding cuts actual welding time in half. Compared with the U-gap method there is also some saving in welding time, but, the big factor is the elimination of all preparatory machining of plate edges.

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Since less weld metal is required to fill a straight-sided gap, it is obvious that fewer electrodes are used in making welds by the Straight Gap method. Actual tests show, for example, that 2 2/3 pounds of 3/16-inch MUREX ELECTRODES will completely weld a 12-inch seam in 1½-inch plate.

TESTS PROVE SUPERIORITY OF STRAIGHT GAP WELDS

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Free bend specimens, ⅝, 1 and 1½ inch plate, of welds made by the Straight Gap Method with Murex Cresta Electrodes.

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MUREX

HEAVY MINERAL COATED ELECTRODES

MEMBER AUDIT BUREAU OF CIRCULATIONS

THE WELDING ENGINEER

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FROM MINES TO RODS
UNDER GULFSTEEL CONTROL

Review of Experience of a Public Utility in Welding Plates and Structural Shapes

■ By G. F. ALLEN
Engineer, The Detroit Edison Company.

A FEW years ago, we commenced substituting a completely welded steel cell in place of the previously used hyrib and plaster cells for segregating oil switches. These cells were single-compartment, approximately 2 ft. 8 in. by 5 ft. 6 in. high, and were made of ⅛-in. plate with 2x2x¼-in. corner angles. The difficulties encountered in this first venture were mainly confined to the fitting of the doors and the warping of the large-size plates due to lack of experience in welding large thin plates to a frame. In later jobs this latter difficulty was mainly overcome, although it will always demand careful attention. The doors gave considerable trouble, as they were practically the full size of the front and the specifications demanded

Welding Is Applicable to the Fabrication of Steel Switch Cells.

that when closed the door would rest evenly on the stops on all sides and also that a clearance of 1/16 in. be maintained between the door and its frame. These specifications were met at considerable expense of time and money by careful fitting in the field. As this class of work advanced, permanent jigs were set up in the fabrication plant with the result that in our Essex Station these doors were erected in the field in a very few minutes. We might also note that the size of the cell increased to 6x9 ft. and the height to 12 ft. with three compartments with doors 3 ft. wide by 8 ft. high. Bus compartments were made as large as 3 ft. deep by 9 ft. wide by 20 ft. high.

Paper read before the Highway Congress in Detroit, Michigan, January 18, 1933

Our experience with this cell construction furnishes an outstanding illustration of the importance of making progress slowly. Our first undertaking of the kind was very clumsily and consequently expensively handled. Through the lessons of each succeeding similar job and the consequent gaining of expertness and improvement of technique, the work is now done smoothly and with substantial savings over the previous type of construction. It would be impossible to render on paper detailed instructions which would obviate the necessity of this painful schooling.

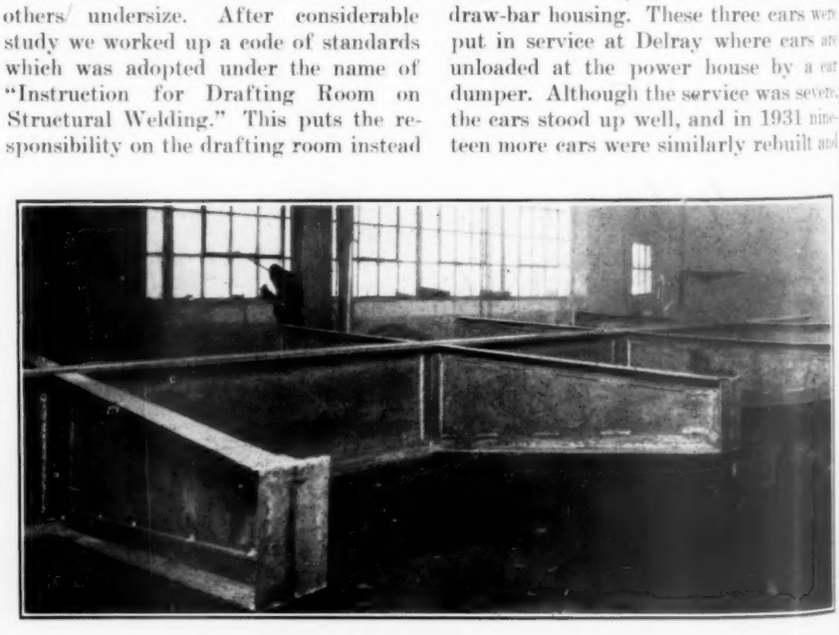
Develops Drafting-Room Standards on Welding

When welding was first used on structural work, riveted construction was well established with standards and instruction codes. Welding had no such standards, and consequently a great deal of drafting-room practice was simply to note that certain pieces were to be welded, leaving all responsibility up to the welder who is untrained in the theory of stresses. As a result some welds were oversize and others undersize. After considerable study we worked up a code of standards which was adopted under the name of "Instruction for Drafting Room on Structural Welding." This puts the responsibility on the drafting room instead of on the welding operator. It also provides a record of the amount and size of welds on each job, in case of future changes.

Later, welding was extensively used to rehabilitate worn-out 50-ton gondola cars used for coal handling. It was decided to

Welded Cells Enclosing High-Tension Disconnect Switches.

dismantle three cars down to the trucks and rebuild entirely with welded steel construction, except for the draw-bar lugs, which, on account of heavy impact stresses involved, were riveted to the draw-bar housing. These three cars were put in service at Delray where cars are unloaded at the power house by a car dumper. Although the service was severe, the cars stood up well, and in 1931 nineteen more cars were similarly rebuilt and



Rebuilding the Underframe of a Steel Coal Car.

Rebuilt Coal Cars Are as Good as New.

Interior View of Welded Rebuilt Car.

another ten in 1932. A saving of 20% was made over the estimated cost of riveting on the first three cars and this was increased to 25% on the later jobs. Some covered wire was used for flat welding on this job.

Demonstrates Adaptability of Welding to Heavy Structures

During the latter part of 1930 and early part of 1931, we designed and built at the Connors Creek coal wharf, a ramp for a drag-line car-loading installation, using welded construction. There were no rivets or erection bolts used in the entire job. Considering the job as a unit, carrying substantial loads which required heavy sections, we were given an opportunity to demonstrate the adaptability of welded construction to structures.

In plan, the outline is an isosceles triangle. A flat deck, about 16 ft. above the top of the rail, ends in an apron extending downward about 8 ft., the apron forming the base of the triangle. Wing walls of steel plate extend about 5 ft. above the deck. The head post is located at the apex of the triangle and takes the pull of the bucket and tail car. The maximum stresses in the head post average about 220,000 lb. in compression and 150,000 lb. in tension. All connections were designed for rigid construction. The material was furnished and erected from drawings made to scale. Our details were very complete, with symbols specifying location, size and length of weld, making it possible for the inspector to follow the job closely and see that specifications were strictly adhered to; and in case changes are required in subsequent years, our files will furnish us accurate detail information. The work was satisfactorily completed.

The connections should have been designed as flexible. This structure was built on poor soil, and the column footings settled unequally, throwing additional stresses upon the welds. It is interesting to note the behavior of the members affected. Sections were distorted before there were any indications of failure in the weld. The structure did not fail and corrections were made to the weakened parts.

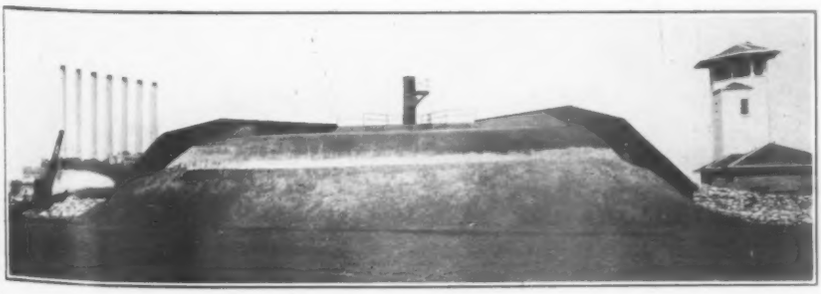
About this time a system of zoned air control was installed in our Delray boilers, which gives the operator control of the amount of air fed to any particular portion of the coal bed. The illustration shows the possibilities of welded construction when the shape of the piece is very irregular and space is limited. Riveted construction was very obviously out of the question and it was a choice of castings or welded plate. Two other considerations were also favorable to the welded construction. First, the much greater ease with which the plates could be field fitted to the existing steel and, second, the considerably reduced weight of the plate.

Labor and Material Saved by Welding Roof Trusses

In the latter part of 1931 a welded Pratt type of roof truss was designed and fabricated for an addition to the Delray Research Laboratory. The decision to use welded construction was based on an estimated saving in material and labor by eliminating gusset plates, which in this case would be quite large due to the truss being shallow and flat. The span was 40 ft. 0 in. and the trusses were spaced at 6-ft. 3-in. centers. The truss supported a deck load of precast slabs with composition roofing and a suspended plastered ceiling. With a snow load of 40 lb., the total design load was 80 lb. The top and bottom chord section was made up of a 12-in. 31.8-lb. I-beam split along the center line of the web to form T-sections. Diagonal members were 2x $\frac{3}{8}$-in. bar iron and the verticals were 2x2x$\frac{1}{4}$-in. angles. The truss was fabricated in our Beecher shop from a detail drawing which by now has been developed to a point equal to a drawing of riveted construction.

Ducts of Irregular Shape Are Easily Fabricated by Welding.
(These all-welded gooseneck ducts are a part of the automatic air control to boilers in the Delray station.)

In 1932 a very light roof truss of the Fink type was built for a span of 34 ft. 0 in., spaced at 18 ft. 0 in. centers. The top chord was a 7-in. 15.3-lb. I-beam split at the center line of the web; the bottom chord a 6-in. 12.5-lb. I-beam similarly split; and the struts were 2-in. 2.6-lb. channels and 3x2$\frac{1}{2}$x5/16-in. T's. The tension members were 3x2x$\frac{1}{4}$-in.



View of Welded Coal Ramp at Conners Creek Station.

Program of Annual Meeting of American Welding Society To be Held in New York City, April 27th and 28th

Welding and business progress will be the general theme of the annual meeting of the American Welding Society, to be held at the Hotel Governor Clinton, New York City, Thursday and Friday, April 27th and 28th. Special committees on welding will render their reports, and papers will be presented on welding and industrial rehabilitation. A feature of the Thursday morning session will be the award of the Samuel Wylie Miller memorial medal for advancement in welding. The two-days' program is as follows:

Thursday, April 27th

10:00 a. m.—Governor Room—Business Session, President F. P. McKibben presiding.
Report on society activities by President McKibben.
Tellers' report on election of officers.
Award of Samuel Wylie Miller Memorial Medal.
Review of section activities by local section chairmen.
Discussion.

12:30 p. m.—Luncheon—Florentine Room (optional).

2:00 p. m.—Governor Room—Committee Reports, Vice-President J. J. Crowe presiding.
Presentation of report of Pressure Piping Code Committee by T. W. Greene, chairman of committee. Discussion.
Presentation of report of Committee on Use of Welded Steel Parts for Machinery Construction, by G. D. Spackman, chairman of committee. Discussion.

7:00 p. m.—Dinner—Florentine Room (optional).

8:00 p. m.—Governor Room—Technical Session, J. B. Tinnon, chairman Meeting and Papers Committee, presiding. Lecture by President F. P. McKibben on "Erecting Steel Buildings and Strengthening Steel Bridges by Welding."

Friday, April 28th

10:00 a. m.—Governor Room—Technical Session, Past President F. T. Llewellyn presiding.
Address by Charles F. Abbott, Executive Director, American Institute of Steel Construction, on "Must Industry Be a Pawn or a Power?"
Address by Willard T. Chevalier, Publishing Director, *Engineering News-Record* and *Construction Methods*, on "Welding—A Factor in Industrial Revival."

12:30 p. m.—Luncheon—Florentine Room (optional).

2:00 p. m.—Governor Room—Meeting of American Bureau of Welding, Director C. A. Adams presiding.
Reports of committees.
Election of officers.
Fundamental Research Committee—progress reports by university research workers.

6:30 p. m.—Committee Room, third floor—Meeting of Board of Directors, President F. P. McKibben presiding.
Review of society activities.
Appointment of committees and officers.
Plans for the coming year.

It is urged that all local sections have representatives present at this meeting, and particularly at the Thursday morning session at which they will report on their local section activities and enter into the discussion which is to follow.

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angles. After considering several designs, an estimated saving of 12% in labor and material was made by using a welded truss instead of a riveted truss. This truss was used in the coal unloading house at the Dequindre coaling station.

Castings have been replaced by welded steel in a few instances, and these have proved very satisfactory from the standpoint of cost and delivery time. Two valves in our ash system at Trenton Channel, at an estimated cost of $200, showed a saving of $50 or about 25% when manufactured out of welded steel, and a number of coal chutes for Delray stokers showed even greater savings. It is to be noted also that the elimination of patterns means the elimination of necessary storage space.

The smoke uptakes or breechings connecting the boiler to the stack are very irregular in section. At the boiler they are of rectangular section, about 3 ft. 6 in. by 24 ft. 5 in., and at the stack they are semi-circular, of 16 ft. 0 in. diameter. Owing to the shape, it is impossible to flange the plates for corners, so angles are opened or closed to make the joint. The uptakes must be gas tight. For riveted uptakes ¼-in.-thick plates are the minimum for caulking and ½-in.-diameter rivets spaced on 2½-in. centers are required. This makes two lines of rivets for each corner. For each rivet two holes must be laid out, one in the angle and one in the plate. This must be very accurate and is a costly operation in fabrication. Also the corners of all plates must be scarfed and the edges of the plates bevel sheared to caulk.

For welded uptakes the corner angles are omitted, also the plate can be 3/16 in. thick, as no caulking is required. The seams must be continuously welded with a 3/16-in. bead. It can be seen that in the material 25% is saved in the plates as well as the entire weight of the angles. The field work for riveted construction consists of two rows of rivets and caulking two edges per corner, while the welded construction consists of one 3/16-in. bead.

The total saving is very appreciable, and similar savings are effected in all duct work of which there are many types.

To Read Papers on Pressure Vessels and Steel Homes

The March meeting of the Los Angeles Section, American Welding Society, was omitted because of the "banking holiday" and the earthquake. A real treat, however, is promised for the meeting on April 20th, at the Mona Lisa Cafe. "Stress Relieving Furnaces for Large Welded Pressure Vessels" is the subject of a paper by C. E. Olmstead, engineer, Mahr Manufacturing Co., Minneapolis, Minn., which will be read by W. D. Cleghorn, Pacific Coast representative of the company. This will be followed by an illustrated lecture on "Frameless Steel Homes" by Bennett Chappell, Jr., of the American Rolling Mills. It is announced that this may be the answer to many prayers for an earthquake-proof home.

Engineering Groups to Meet in Chicago

Twenty engineering and scientific organizations have perfected plans to hold their conventions in Chicago during Engineering Week, June 25th to 30th. The combined membership of these groups is over 100,000. This will be the greatest gathering of engineers ever held in this country. During this week will be held the Sixth Midwest Engineering & Power Exposition, at the Coliseum. Leaders in the iron and steel industry will discuss the specific problems of their industry in relation to present-day conditions with the idea of outlining practicable plans for rehabilitation or "renovizing" as a good business proposition. The Century of Progress will add mental stimulation because of its presentation of widely diversified modern scientific and industrial achievements.

Welding Copper-Alloy Tanks With the Carbon Arc

AUTOMATIC welding with both the carbon and metallic arc is being used in the manufacture of water heaters by the Bastian-Morley Co., Laporte, Ind. The following description of the construction and welding procedure has been supplied by L. P. Corsbie, superintendent of the company's plant.

THE carbon-arc welding of Everdur shells for hot-water heaters requires no filler material and makes a water-tight joint.

In the construction of automatic hot water heaters, torpedo-shaped shells of Everdur metal are employed, these being furnished by The American Brass Co., Waterbury, Conn. These shells are 48 in. long and are 12, 16 and 20 in. in diameter. To complete a shell, seven drawing operations are necessary, and the shell is annealed between each operation. The head is drawn to No. 9 gage, and the cylindrical part of the shell varies between 0.056 and 0.078 in., depending on the diameter.

These shells are put on a large specially designed pneumatic press and two 1-in. pipe spuds and a flue collar are formed in them. The spuds are formed in the proper size for a 1-in. pipe tap on the two smaller openings, thus eliminating the necessity of welding any spuds to the top of the cylinders. A ½-in. flange forms the flue collar. To this flange is butt welded a copper flue, which extends through the heater and through the head stamping. Copper is used for this flue since it has a high heat conductivity and, of course, will absorb a large portion of the heat traveling through the flue to the vent pipe.

This company has been successful in welding the copper flues to the Everdur collars without the necessity of annealing to the extent that the pressure will bulge the flues out.

Two holes are also drilled into the sides of the cylinders, into which are cold forged two Everdur spuds, this operation being performed on a 300-ton pneumatic press. The bottom stamping, which is formed out of grade "A" Everdur, is then forced into the bottom of the cylinder by a specially built pneumatic press until both edges are flush, thus giving a tight joint and leaving no gaps.

Next the tank is set in a vertical position on the carbon-arc welding machine, and the two edges are fused together without the use of filler material. A mixture of 90% fused borax and 10% sodium floride mixed with enough alcohol to make a paste is used for a flux. This method of welding results in very few rejected welds.

In some cases, the bottom is forced 8 in. into the cylinder, a copper band is strapped around the outside of the joint, and the bottom is fused to the side sheet, the molten copper flowing into the joint by capillary attraction and making a tight joint.

Carbon-Arc Welding an Everdur Shell for a Water Heater.

The last operation is to weld the bottom of the copper flue to the bottom Everdur stamping, thus completing the forming of a very satisfactory pressure vessel for an automatic water heater.

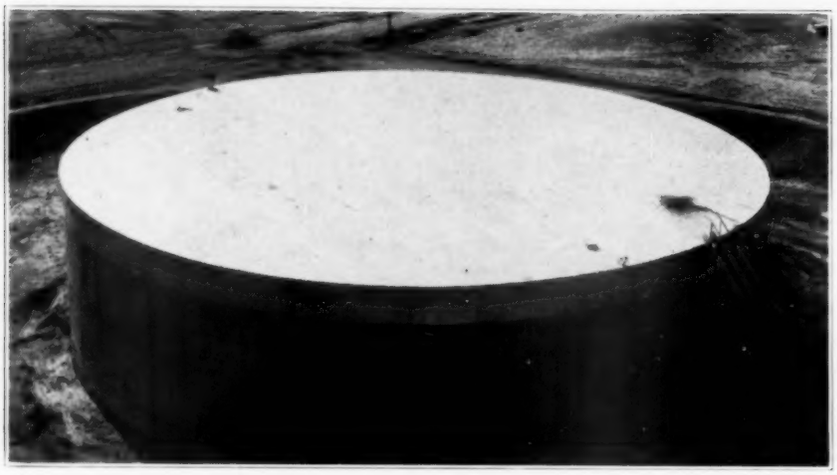
A small percentage of these tanks are subjected to an impulse test in order to determine their ability to withstand the alternating pressure and the breathing effect to which the tank is subjected in actual service when the faucets are turned off. In this test, the tank is filled with water and the cylinder submerged; then the internal pressure is raised from 50 to 300 lb. fifty-three times a minute. It is not expected that any tank will stand such a severe test indefinitely, but any sign of failure will indicate the weakest part of the structure. The welds frequently stand this test when the shell itself bursts. These welded shells have been tested up to 700 lb. per sq. in. hydrostatic pressure without distortion. A 350-lb. hydrostatic test is applied to all shells, and the rejections due to defective welds are very few.

Welding the Bottom Head in the Heater.

Everdur tanks can also be made from sheets and stampings such as that of a steel range boiler. In this case, the polarity of the welding machine is reversed. The flat sheet is flanged ¼ in. so when it is rolled into a cylinder the flange can be fused down by the arc, thereby eliminating the need for filler rod.

The Bastian-Morley Co. are also making satisfactory welds on Everdur tanks by feeding Everdur wire through an automatic welding head. The maximum speed of welding in this case is 16 in. per minute, on No. 15 gage metal, using ⅛-in. Everdur welding wire.

All these Everdur welded tanks are guaranteed for 20 years, regardless of water conditions and pressure. Of the thousands of tanks in service, not one has been returned because of defective welding.



Welding is No Longer the Exception But the General Rule in the Field Erection of Tanks

Paper read before the Welding Conference at Purdue University, Lafayette, Ind., December 8-9, 1932

Field Welding of Tanks

■ By D. C. WRIGHT

Operating Manager, Graver Tank & Manufacturing Corp.

AS YET, the general subject of field fabrication by welding is largely a matter of individual technique and local development. Our company, for example, has records of something over two hundred welded tank jobs erected in the field using all of the generally known methods at one time or another during the two years since the present control has been in charge, and I do not believe that it would be any great stretch of the truth to state that probably each job has developed at least one and possibly more new problems, most of them minor and easily solved, but some of which have been almost fundamental in the importance of their solution.

The reason for this is readily apparent, when one considers the conditions which govern a "field" job. Such a job presupposes that for one reason or another the actual assembling of the parts composing a complete unit must be done at some point remote from the shop wherein fabrication is done.

Many Different Types of Field Jobs

Whether the job consists of the fitting up and erecting of a simple basement tank too large to pass through doors, downstairs or around corners, the assembling of knocked down sections of the ordinary bulk tanks common to every distributing station, or the erection of large field storage tanks up to 100,000 barrel unit capacity, it is still a "field" job in the sense that it is divorced entirely from all plant assistance or backing.

In other words, as far as tooling is concerned, only the sketchiest of readily portable equipment can be made available, with no protection from the elements and entirely without any of the supporting help of the service and maintenance departments available in any fabrication plant layout.

The Problem of Personnel

As for personnel, actual dependence must usually be placed in the single foreman or erecting superintendent sent out from the home base. True, it is, that field tank erection has gradually created a fraternity of its own, similar to that found in the business of bridge building, whose members often accompanied by wives and families literally "follow the job" from Maine to California and from Florida to Oregon. These men are peculiarly "tank" builders and must not be confused with boiler-makers, into which category organized labor groups insist on placing the jobs incidental to tank erection.

Actually, it has been amply demonstrated on many jobs that irrespective of any question of union restrictions, members of the boiler-makers trade are only indifferently equipped to erect field storage tanks as compared with regular tank erectors.

However, even though the members of this clan or class follow the job and seem to gravitate toward any field job throughout the country as naturally as flies find the saucer of syrup, the fact remains that almost without exception they are "freelances," owing allegiance to no particular employer and leaving the actual responsibility strictly up to the foreman.

Hence it is that the question of proper erection resolves itself essentially into dependence on one or the other of two main factors:

(1) Careful, accurate shop fabrication

(2) Field technique and equipment to achieve the desired results.

To these might be added a third factor, which is a combination of these two.

Until recently the emphasis has been almost entirely upon the first method mentioned, all material being passed through a fabricating plant wherein such shapes, locations, attachments and fastenings as were required were carefully laid out, developed and incorporated in the material, often to the extent of complete shop fit-up and assembly of doubtful units. In such a case the field equipment consisted merely of the proper hoisting device, whether it be gin pole, boom, or derrick for lifting material into place, and the necessary bolting, riveting or welding equipment to secure it in that place.

However, the tank-building fraternity, like many others, has amply demonstrated its qualifications for a place in the gold-medal class of poor economists during these past few years, in that they have allowed themselves to be drawn into a cut-throat price war wherein no one has profited. And I say "no one" advisedly, inasmuch as even the buyers have often failed to secure the full benefit of price cuts in some supplier's frantic efforts to bring costs into approximate line with a sales price from which all gravy and most of the meat have been extracted.

Most Consideration Now Given to Field Technique

One of the developments of this situation, on the other hand, has been the transfer of erecting emphasis from shop fabrication to field technique; the reason

being that in the frenzied search for means of reducing costs, the matter of freight and handling was found to loom large in many cases. In other words, it obviously simplified matters materially if, instead of shipping material from the steel mills into a fabricating plant, unloading it, processing it, loading it again into cars and transporting it to some remote field location, the major portion, if not all of it, could be shipped directly from the mill to the job.

Naturally, it was assumed that at best there must be a material increase in the man-hour requirements of the field job under this latter method of handling, but in many cases it was found that even this supposition wasn't correct, and that in any event the savings effected in one direction were ample to balance the increased cost in others and leave a comfortable margin, which more or less brings us down to the situation as it exists today.

True, there are all gradations in the transition from shop fabrication to 100% field erection still to be found. Some states still refuse to countenance welding in any form in the construction of oil storage tanks, with the result that riveting or bolting must be employed. In other locations, customer preference, precedent, the nature of the work, or perhaps the overall economic balance dictates a compromise method of assembling wherein welding may play a major or minor part.

Generally speaking, however, for the purposes of this paper, it can be assumed that any vessel assembled by rivets, bolts, screws or pins can be duplicated in its essential characteristics by means of welding with results fully as satisfactory from a functioning standpoint.

What then are the essentials to insure a good commercial job of field welded assembly?

Requirements for Good Field Welded Assembly

First, there is the engineering, for while pieces of steel can be welded in either of the conventional forms of joint—namely, single or double lap, and butt weld—each may possess distinct limitations or advantages when considered for a particular job.

Second, we must have proper equipment for economically and accurately fitting-up the various components preparatory to attaching them together.

Third, we should select the proper welding wire or rod for the various parts of the job, and

Fourth, we must insure the employment of capable welding personnel.

A fifth requisite in the case of shop-fabricated material would have to be inserted in this line-up previous to number two above-mentioned, and would provide that such fabrication be accurately done to insure the matching of adjoining parts in the field with the minimum of adjustment.

Parenthetically, let me point out that one of the first laws of successful field economics dictates that the crew "get in and get out" with the minimum of delay. Wherever cut-and-try methods, delay or corrective work is found to be necessary, it can almost be assumed as axiomatic that money is going to be lost on that job.

For our purpose in this discussion we can temporarily waive any lengthy dissertation on the elements of engineering, shop fabrication, welding rod or welder qualifications, and confine ourselves for the present to a consideration of fit-up methods.

Use of Fit-Up Bolts and Pins in Field Work

Generally speaking, the functions of any fit-up method is to locate positively one piece of metal in its proper relationship to another piece of metal at as economical an over-all cost as possible; and obviously no better method can be devised for achieving this end than the employment of tightly drawn bolts spaced at sufficiently frequent intervals to insure the "lay-up" of the metal surfaces as well as their exact positioning with reference to each other. After assembly, the bolts are either welded to the surrounding plates to seal all openings around the threads, or they are withdrawn and the holes filled by means of welding.

However, the use of bolts, even in limited numbers, presupposes the presence of holes into which to insert the bolts, and this in turn makes obligatory the provision of punching or drilling equipment at some point along the line. This again means possible expense for handling or fabrication; so that while it unquestionably assures the easiest and most positive fit-up in the field, its applied over-all cost may be prohibitive.

In this connection, we might take the risk of prophesying the ultimate use of the newly developed Temple Gun, which by the employment of the delayed-action principle makes possible the driving of pins, rivets or screws into blank metal without the necessity of first providing holes for their insertion. However, for obvious reasons, this method cannot be considered as economically applicable at present.

Barring the use of fit-up bolts or pins in some form or other, we next come to some sort of clip which can be clamped or tacked onto the mating edges of two plates to insure their engagement. The particular method or design used depends to a large extent on the nature of the joint, the conditions surrounding the job, and the ingenuity of those in charge.

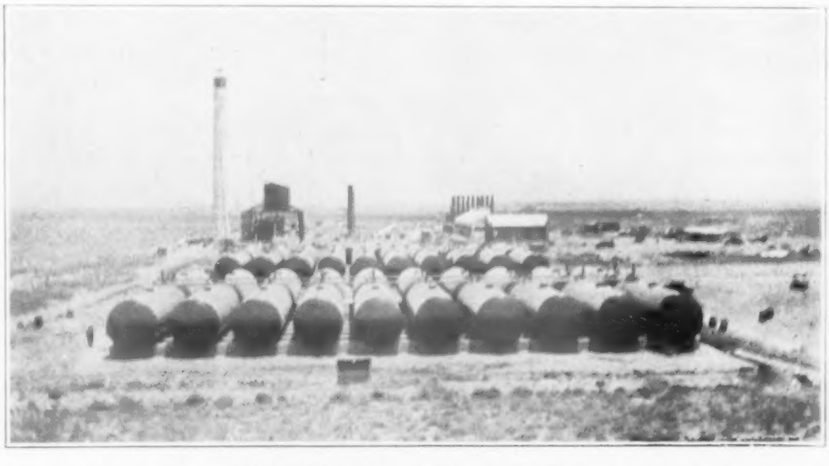
With butt joints, it is obvious that a great deal more care must be taken to secure the mating of edges than when laps are employed. Not only must the alignment of the edges be exact, but the edges themselves must also be perfect as regards squareness.

Assembly for Butt Welding Facilitated by Using Clips

The most common assembly device in butt welding is a simple strap-iron clip welded to each face of a plate and extending out from the edge to form a "V" or slot of the width of the plate thickness. By spacing these clips at whatever frequency is required along the edge of one plate, the edge of a mating plate can be inserted into the notches and thus brought into close alignment.

A modification of this method uses a clip welded to the opposite faces of one of the plates; but instead of depending upon the fit of the adjoining plate in this slot to insure alignment, a set screw is used, extending inward through the outer end of each clip, and these screws are utilized to center the plate on its adjoining edge.

Still another erecting situation may make it seem advisable to secure alignment of edges by the use of small angle clips, each with a hole through the free side, which are welded on the sides of



These Forty Field-Welded Storage Tanks Are Each 40 Feet Long and 11 Feet in Diameter.

abutting plates and brought into alignment by means of through pins or bolts. In lieu of special angle clips, ordinary square or hexagonal nuts through which drift pins can be inserted are perfectly satisfactory for the purpose, and constitute a device which has been common in welding assembly since its earliest days.

One decided disadvantage, from the customer's standpoint, of the use of any type of fit-up clip attached to the plates by welding derives from the fact that in order to be effective, such attachment must be of a fairly substantial nature, which in turn makes its removal productive of a considerable gob or fin of weld metal, making a rather unsightly effect in the appearance of the finished tank. This, however, applies mostly to butt-jointed work, as it is possible with lap joints (owing to the telescope method of assembly) to so arrange the clipping as to have it appear only on the inside of the shell.

When all is said and done, the obvious purpose of a field tank is to provide liquid storage at as low a cost per gallon as can be obtained under the conditions involved; and it naturally follows that, if the element of cost is satisfactorily taken care of, considerable lenieney will be extended in the matter of appearance. For this reason I look for a gradual swing to the all-welded field-fabricated storage tank.

Overall Cost Determining Factor in Choice of Joint

Continuing our consideration of field fit-up, we shall outline briefly the three types of joints available to the engineer. These are, as mentioned before, the single lap weld, the double lap weld and the butt joint. Each of these has its particular merits and disadvantages; and while proponents of each stress the matter of structural strength or weakness, I feel that this can be largely ignored, since a good joint can be made by either method if proper technique is employed. In other words, the matter again resolves itself into a question of final overall cost, which, as already suggested, may vary as to location and type of job.

Obviously, the butt joint necessitates the use of less metal than any form of lap, and this may conceivably prove to represent sufficient savings to offset any extra cost involved in its use, since the normal lap on a large tank varies from 2½ to 3 in. The extra costs in the use of a butt joint derive from the necessity for accurate matching of adjoining edges, which usually makes some form of trimming, chipping or planing, and from the difficulty of fitting up and holding these edges in alignment preparatory to welding.

It is readily apparent that the use of a lap joint obviates the necessity for edge treatment of any sort, since the slight variation in edge alignment natural to mill practice would cause no inconvenience when backed up by a lap of any kind, while it would be sufficient to cause real trouble if converted into a varying gap between two abutting edges. Accordingly, the lowest possible price can be paid for steel with no mill extras for special trimming involved where a lap is employed.

Overcoming Difficulties in Welding Butt Seams

As for the welding itself, it takes very little imagination to visualize the relative difficulties of making a satisfactory butt weld in the vertical plane of a tank wall on the horizontal or roundabout seams as compared to a downhand fillet weld in a lap joint.

It is extremely difficult for a welder accurately to follow a horizontal butt seam. In fact, the writer has examined jobs where the actual bead had been laid down in an area away from the real juncture of the plate edges; this is due to the tendency to follow the seam instead of a line slightly above the joint, and hence the molten metal falls away from the joint and builds up along the edge of the lower plate rather than in the joint itself.

However, both our company and others in the field have at one time or another made use of most of the types of field welds and, we feel, as mentioned before, that the selection of any particular joint for a specific job is entirely an open question to be decided finally on the merits of the individual problem.

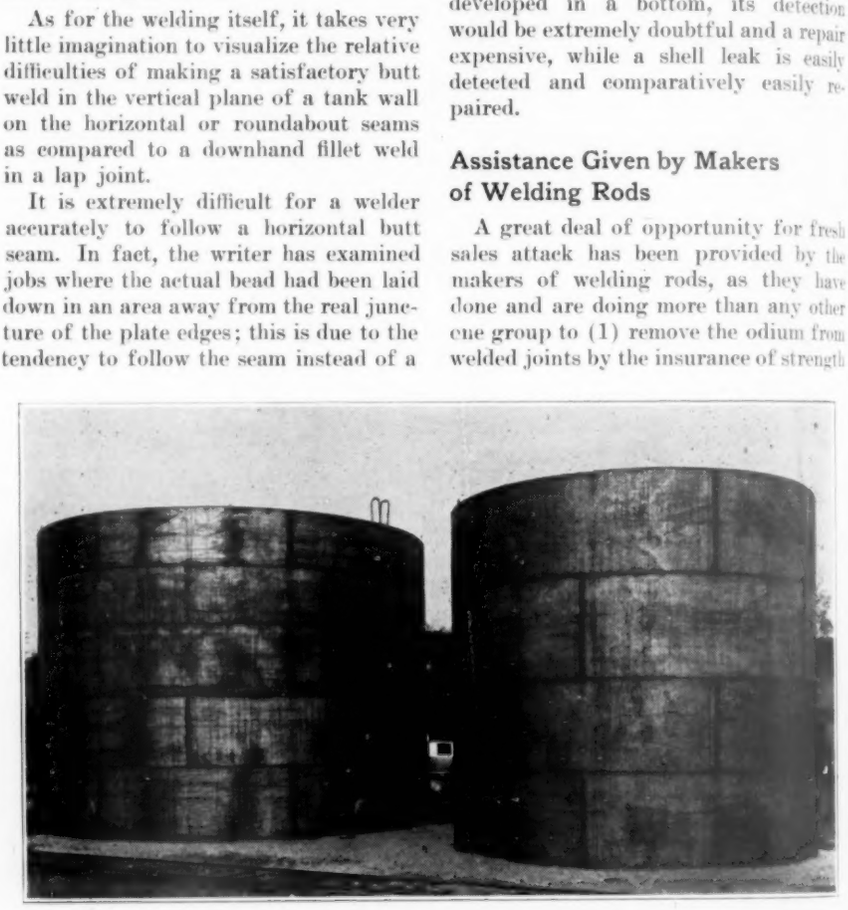
Welded Roofs and Bottoms First to Find Favor

The assembling of tank roofs and bottoms has drifted farther toward welding than has that of shells or side walls, only a very small percentage of customers demanding a riveted type of construction in either place. My feeling has been that the growth of welded bottoms has represented salesmanship, which could just as well have achieved similar results if applied to shells.

True, a tank bottom is supposedly supported by a grade, but after all it is definitely out of sight once it has been lowered into position; and it is evidence of a queer psychology that welding has found favor in such a location, while it still encounters considerable opposition in a readily observable location such as a tank shell. In other words, if a leak developed in a bottom, its detection would be extremely doubtful and a repair expensive, while a shell leak is easily detected and comparatively easily repaired.

Assistance Given by Makers of Welding Rods

A great deal of opportunity for fresh sales attack has been provided by the makers of welding rods, as they have done and are doing more than any other one group to (1) remove the odium from welded joints by the insurance of strength equivalent or superior to that of the parent metal, and (2) compete with other types of joints on a plain dollars-and-cents basis.



Field-Erected Tanks for Bulk Storage.

Originally welds were all tensile strength with little or no ductility provided for, with the result that, frankly speaking, they were inapplicable to many jobs where welding enthusiasts tried to use them. The result was a lot of disastrous failures, which bore their natural fruit of distrust and stringent control.

Now we have rods that meet the peculiarities of special steels, besides providing strength and ductility superior to that of the parent metal.

In spite of the fact that men like Uncle John Kellar of Purdue and others in similar lines of effort have been pointing out the results of the application of heat to metal for years, we still have neglected to use similar reasoning in our

application of welding heat, with the result that many costly mistakes have been made.

Any well-prepared welding assembly has definite provisions made in its shop and field specifications, its drafting and its supervision for the particular technique to be used. Such provision should cover class of steel, brand or class of rods, number of beads, size of rod, current characteristics, location of ground, and in fact all pertinent data which will set forth any special conditions that the particular job seems to possess. Such a set of instructions is no more than should be provided for any job, whether it be in the machine shop, the plant erecting bay or the field; but because of the wide variation between jobs, men and conditions in the field, advance study perhaps pays larger dividends in field work than in any other line of activity.

Division of Field Personnel

After the planning of the job is taken care of, the next detail of importance is the assurance of adequately capable operators to perform the work. We find the personnel of a field crew on welded structures divided roughly into two groups, the first having to do with the laying or hanging of the steel, which consists of locating the component parts in the correct positions, and the second group being the welders, who perfect the final joining of these parts.

On small jobs it naturally follows that the welder may serve also as a fitter-up; but it is by no means possible to reverse the process. The field welder, exposed to wind, dust, and other variables, must be a thoroughly competent man; and to insure this fact with reasonable certainty, some form of qualifying tests should be set up under which each applicant for a welder's job can be checked as to his capability and at least a rough classification established on the basis of this capability.

Most companies have their own set-up, which they consider adequate; but for purposes of illustration, I will cite the test procedure used by the writer's concern in both the shop and field organization, which is substantially the same as that employed by any well-organized welding group.

Test plates are made up and carried in stock at the plant, where they are available for use by the plant welding superintendent, or for shipment with the regular field outfit of tools to each field job where welding is to be done.

Types of Welds for Qualifying Welders

For qualification purposes the following six types of welds are selected as being those most frequently encountered and most likely to give trouble:

(1) Downhand horizontal lap, heavy coated rod

(2) Downhand horizontal lap, bare rod

(3) Downhand horizontal butt, heavy coated rod

(4) Overhead horizontal butt, heavy coated rod

(5) Vertical butt, heavy coated rod

(6) Downhand vertical lap, heavy coated rod.

While these, of course, do not cover the entire range of possibilities, it is felt that they represent the most important types of welds from the standpoint of the necessity for insuring quality; and also it seems logical to suppose that an operator who could successfully pass a test on this group would have no difficulty in satisfactorily handling other types that might come to hand.

At the outset of the establishment of this routine, all welders on our payroll were asked to subscribe to these tests, and their standing thus was established through the use of easily applied grades. From this point on, each new applicant for a welder's berth either at the plant or in the field is equipped with proper test pieces and given an opportunity to demonstrate his ability under the watchful eye of the foreman.

The procedure varies between the shop and the field only to the extent that the "pull" tests on specimens welded in the field must await their return to the home office before this portion of the record can be completed. In the meantime, however, it is felt that careful watching of the man's technique and a visual inspection of the weld itself will amply equip the foreman to judge of the advisability of employing the man on particular classes of work.

Individual Record of Each Welder

An office record of each man's performance is kept; and in order to establish his fitness and prevent needless expense, a pocket identification card is issued to the man, testifying to his having passed the necessary tests to qualify him as a class 1, 2, or 3 welder.

Should an initial test develop the fact that the man, while capable of doing plain downhand welding, tacking up, and the like, is hardly a safe operator to trust with important work, where quality is essential, he may be given a grade as class 2 or 3. If, then he desires at a later date again to attempt to qualify for a higher grade, this is arranged for on the basis of a nominal charge to cover actual materials used. The expense of the original tests is borne by the company.

Like any development in other lines, the evolution of welded tank structures has been gradual from some preceding type in the matter of design; and for much the same reason that to date it has been impossible to "sell" the idea of an ocean liner without funnels even where the practical need for funnels has been eliminated, so we have found it necessary to adhere for a long time to a number of details which have been fixed in the user's mind through long years of riveted construction as being necessities.

Our company, for example, during the past two years has built several successive lots of storage tanks for a certain large user, all of substantially similar overall characteristics as regards size and fittings. However, it is interesting to note that the first of these tanks were all-riveted, while succeeding lots have eliminated rivets from longitudinal seams and increased the spacing on roundabout seams to a point where the rivets have admittedly no practical value, and it is now rumored that future orders will call for completely welded construction with no other means of attachment used.

Elimination of Structural Angles in Welded Tanks

Similarly, in the matter of large field storage tanks, it has been the custom from time immemorial to make use of a heavy angle iron at the juncture of side walls or shell to the bottom. Naturally, in the case of a riveted construction and barring any ability to flange the bottom to form a mating surface with the shell, it follows that the use of a bottom angle was essential. When welding came into use, this bottom angle was retained largely because of precedent and because it formed a convenient means of locating the shell plates.

However, from the standpoint of strength this reinforcement is wholly unnecessary, as in any cylindrical vessel the roundabout or horizontal seams need carry little more than the weight of metal above them, which is never excessive, and except for leakage a shell could merely rest on a tank bottom without actual bond. It is interesting to note in this connection that the first large field storage tanks used no metal bottom at all, and that several patents have been issued to cover various forms of storage tanks without integral bottoms. We now find a number of instances of tanks being erected with no bottom angle being used, the shell plate being merely T-welded to the bottom.

Avoiding Settling of Grade to Prevent Stresses

One very important point which this last brings to mind is the absolute necessity for the securing of a firm and positively level grade or footing for any tank to be erected as a full-welded job. Our foremen are instructed to refuse to proceed with the erection of a tank until they are satisfied that the grade, which as a rule is supplied by the customer, is entirely true and firm. Out-of-level condi-

tions or the use of loose "fill" for grade making purposes may cause a settling, which serves to change the entire balance of stresses or strains in a structure, and ultimately is more than apt to cause disaster. For example, a condition of this sort applied to a tank constructed without a bottom angle would subject the bottom joints to a severe stress and likely result in failure.

Where open-top tanks are used with some form of floating or adjustable sealing roof, it is highly desirable that straight, vertical sides be available; and sufficient settling and distortion have been known to occur as to render the floating members entirely inoperative.

I visualize ultimately almost complete elimination of present-day tools from steel plate and structural shops, the design and application of new and at present unheard-of tools, fixtures or devices for jigging and erecting field structures, and the gradual development of an entirely new approach to the problems of construction and a new technique in their solution.

In the setting up of so-called welderies and the substitution of welded construction to parts hitherto accepted as essentially cast, forged or machined products, a step has been taken toward the goal which I visualize, but just how far or how fast this movement will extend into the realm of "field" work I am not prepared to predict. Here and there today we find bold pioneers with sufficient courage or cash to experiment in a practical way with these dream children, but sooner or later we will find these present-day visions becoming actualities. My own impression is that within five years we will have gone farther toward a goal of this sort than we have in the past twenty-five.

Indiana Ironsmiths Hold Annual Meeting

The 34th annual convention of the Indiana Ironsmiths and Welders Association was held at Purdue University, Lafayette, Ind., Tuesday and Wednesday, April 4th and 5th. The meetings were held in the Michael Golden Shops. The registration totaled 81, which was an increase over last year's registration.

The Tuesday session opened with reports of President A. C. Harrington, Vice-President George Hoeckel, and Secretary-Treasurer Wm. J. Volpert, and the appointment of committees. In the afternoon, Lee Everson, of the Smith Welding Equipment Co., Milwaukee, Wis., gave a talk on "Operating a General Welding Shop, Getting New Business, and What to Do to Improve Business." A dinner was held in the Memorial Union Building at 6 p. m., followed by an illustrated talk by Prof. R. W. Lindley, of Purdue University, substituting for Prof. John F. Keller, who was ill.

On Wednesday morning, the practical mechanics department of the university put on a heat-treating demonstration, followed by a motion picture by the Linde Air Products Co. and a talk and demonstration by a representative of the Lincoln Electric Co. Reports of the committees and election and installation of officers closed the convention.

Equipment was exhibited by the Torchweld Equipment Co., Chicago; Bastian-Blessing Co., Chicago; Logansport Oxygen Co., Logansport, Ind.; and Linde Air Products Co., Indianapolis. Exhibits were also shown of the handiwork of the members, for which prizes were offered. First prize, a Rego welding outfit, was won by A. C. Harrington, of Monon, Ind. Ten dollars worth of merchandise was offered by the Smith Welding Equipment Co. to Geo. Hoeckel, of Elkhart, Ind., as second prize. The third prize, an electric clock, went to I. W. Jenkins.

California Conference on Welding and Cutting

A series of timely papers pertaining to cutting and the welding of ferrous and non-ferrous metals, together with practical demonstrations of the cutting and welding processes, featured the conference on welding held at the University of California, Berkeley, Calif., March 10th, under the joint auspices of the University and the San Francisco Section of the American Welding Society.

The morning was given over to technical papers, and the afternoon was occupied by the demonstrations. Owing to this day being Open House in the College of Engineering, many visitors were present on the campus, and the welding demonstrations were witnessed by approximately two thousand people in addition to the more than two hundred that were registered at the conference. The success of the various demonstrations was made possible through the liberal supply of materials, trained operators, and equipment by various welding equipment manufacturers. Physical tests in tension, torsion and fatigue of the welded specimens proved very instructive.

The following technical papers were presented: "Theoretical Basis of Flame Cutting and Its Industrial Use," by E. V. David, Air Reduction Sales Co., New York; "Basic Principles of Welding Steel," by C. E. Rhein, Linde Air Products Co., Los Angeles; "Developments in Fatigue Tests of Welded Metals," by Prof. G. E. Thornton, State College of Washington, read by Prof. E. A. Hersom, University of California; "New Developments in the Welding of Copper and Copper Alloys," by G. T. Piersol, American Brass Co., Los Angeles; and "Strengthening Wrought-Iron and Steel Bridges," by F. P. McKibben, president American Welding Society, read by C. R. Owens, General Electric Co.

At a dinner meeting at noon, an informal discussion was arranged to explain the trend of welding instruction at the University, and future needs of engineers in welding.

A dinner was also held in the evening, presided over by K. V. King, chairman, San Francisco Section, American Welding Society. There followed a talk on "Heavy Welding with Special Reference to Pressure Vessels" by H. LeRoy Whitney, Kellogg Co., New York.

Earthquake Creates Work for Pipeline Welders

While a vast amount of minor welding will be required in the reconstruction work following Southern California's recent disastrous earthquake, the major damage requiring a large number of welders for emergency work comprised broken oil flow lines, gas transmission and distribution lines, water lines, etc. Some damage was also done in piping systems of many oil refineries in the vicinity of Long Beach.

Shut-downs were necessary at all of the oil loading docks in Los Angeles Harbor due to pipeline breaks. Considerable loss in crude oil and gasoline was also sustained by several oil and refining companies in the district, due to breaks in the pipelines leading to their large storage tanks, and in a few instances the tanks themselves collapsed.

In the breaking of the pipelines, the fact is interesting that the worst damage was done to the screwed lines, the breaks being much more numerous in the lines having this type of joint than those with welded joints. In most cases the repairing of these screwed lines is being done by cutting out the collars (where the failures occurred by the threads pulling) and welding in a piece of pipe to replace it.

Most of the failures in the welded lines occurred in the old lines which were laid before the art of welding pipe joints was developed to the present high point of efficiency. In fact, according to present reports, no breaks of any importance occurred in any welded pipeline laid within the past seven or eight years. While some of the failures in the old welded lines occurred in the welded joints, such was not always the case; and these failures, as stated above, are attributed to the lack of welding experience, knowledge and technique which was naturally more prevalent in the earlier stages of pipeline welding. Almost all of these failures were found in angle welds.

Welding of High Manganese Steel

■ By E. J. SHULER

Metallurgical Engineer, Landis & Landis.

HIGH manganese steel is extensively used in the manufacture of railway track work such as crossovers, switches, frogs, etc. This material has been found best adapted for this use due to its peculiar merit in its resistance to the abrasive wear characteristic of heavy impacts of hard substances rather than that caused by the sliding attrition of hardened parts.

Specifications of this steel used in railway work are as follows:

CHEMICAL

Carbon, per cent	0.95 to 1.20
Manganese, per cent	10.00 to 14.00
Silicon, per cent	0.20 to 0.40
Phosphorous, per cent	under 0.10
Sulphur, per cent	under 0.06

PHYSICAL

Tensile strength, lb. per sq. in.	100,000
Elastic limit, lb. per sq. in.	55,000
Elongation in 2 in.	20%

High manganese steel differs widely from carbon and most other alloy steels. When water quenched from a high temperature at not less than 1830° F., it forms a tough ductile material with an austenite structure.

Up to a few years ago it was considered quite difficult to weld this material successfully. This resulted in the junking of costly castings, causing a high maintenance cost for numerous replacements. At the present time, due to better equipment, the development of coated electrodes designed particularly for this work, and an improved welding technique, successful repairs by welding are being made.

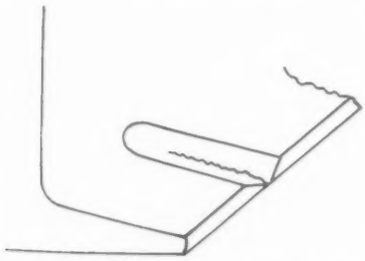


Fig. 1. Metal Is Removed Along the Entire Length of the Crack.

The necessary equipment to carry out this work is as follows: A welding generator of 200 amp. capacity or greater, either gasoline-engine or electric driven. A portable hand grinder driven from an auxiliary generator attached to the welding generator or from a gasoline engine through a flexible shaft. Where there is considerable surface grinding to be done, a track grinder designed for accurate surface grinding should be used. An oxy-acetylene cutting outfit can be used to advantage, especially when it is necessary to remove portions of considerable size that otherwise would require much more time to grind out. With the above, the usual small tools such as heavy hammers, chisels, wire scratch brushes, etc., are provided.

THE maintenance of manganese crossings and frogs on railroads requires diligent adherence to correct procedure.

When a casting is found to be in such condition that it is necessary to make repairs, it should first be given a thorough inspection. A sketch should be made showing the location of cracks or breaks and all parts that have become worn to the extent where rebuilding is necessary. This sketch is not only convenient to have on hand while the work is being done, but it can also be used in estimating the approximate cost of doing the work, also for reference in the future when periodical inspections of the casting are made.

Procedure for Making Repairs

One of the first things to be done when the work is started is the cleaning of the casting. Quite frequently it is found to be greasy and this should be removed, using gasoline or kerosene, or burning it off by the use of a cutting torch if one is available. This done, all loose parts should be removed with a hammer and chisel or the cutting torch.

It is now possible to examine the casting further and see exactly the extent of the damage and determine how to proceed in making the repair. One of the common failures is cracked base flanges, the cracks sometimes extending in as far as the web. In the more serious breaks, these cracks reach into the web and up towards the ball of the casting.

When an inspection of the failure shows that it is only a cracked base flange and not one of the more serious breaks, the following procedure can be used in making the repair: First, the metal adjacent to the crack is removed by grinding out with the hand grinder or cutting out with the torch. If the torch is used to cut out the metal, the surface of the cut is ground afterward. Fig. 1 shows the general appearance of the flange after this grinding or cutting out has been done. Care should be taken to see that the cut-out metal extends beyond the end of the crack, to make sure that the crack or affected metal has been reached along its entire length.

Welding Technique for Manganese Electrodes

With the above preparations completed, the depositing of the metal for the weld can be started. Electrodes best adapted for this work should give a deposit that is both tough and ductile. There are several types of manganese electrodes available that will meet this requirement, but the welding technique is different from that which is used for mild-steel electrode.

In depositing manganese electrode, it will be noticed that the metal boils very slowly and quite often solidifies on the surface before the gases have escaped, resulting in the entrapment of these gases and causing blow holes and inclusions.

By the use of the welding technique illustrated in Figs. 2 and 3, blow holes and inclusions are avoided. As shown in Fig. 2, the movement of the electrode is in the shape of a horseshoe or crescent. Starting with movement No. 1, the welder lays down a bead in the crescent shape shown, and continues into movement No. 2, in which a bead is deposited just ahead of and fusing into bead No. 1. These two movements are shown in solid lines.

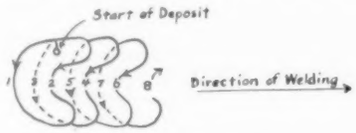


Fig. 2. The Movement of the Electrode Makes a Series of Crescents.

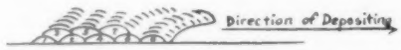
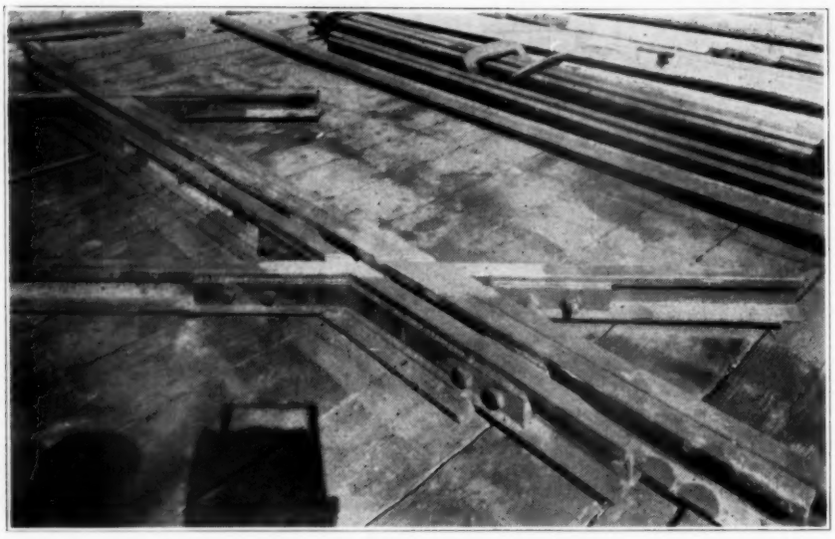


Fig. 3. Section of Weld Metal After Depositing as Shown in Fig. 2.

Movement No. 3 is a continuation of the bead. In this movement, the metal is deposited on top of and in between the beads laid down in the first two movements; this is shown by a broken line.



Partial View of Repaired High-Speed Steam-Railroad Crossing.
(This crossing was built up entirely by cutting with an oxyacetylene torch, electric welding, and then grinding. The shiny deposit near the center of the frogs is manganese material, ¼ in. deep.)

The purpose of going back over and on top of the first two beads is to keep the deposited metal in a molten state for a longer time and allow the escaping of any entrapped gasses. The fourth movement is the same as No. 2 and the deposited metal is fused into bead No. 2. The fifth movement is the same as No. 3 on top and fuses into the No. 3 bead. These movements are continued as shown in the sketch until seven or eight have been completed, thus giving a section of metal deposited approximately 2 to 2½ in. in length.

It is advisable to stop after this much has been done and clean the metal laid down, using a wire scratch brush saturated with water. There is a belief that this quenching with water while scrubbing the deposited metal accomplishes the same as the required heat treatment for this metal. This is quite doubtful, as the deposited metal has cooled sufficiently so that the temperature is too low for this to take place. Yet scrubbing and quenching are desirable in order to remove the slag and scale and to keep the casting cooler. A medium-weight hammer can now be used and the deposited metal peened to relieve to some extent whatever stresses have been set up by welding. After the first layer of the weld is completed and all the slag and scale removed, the same procedure is used in depositing the second layer and any succeeding layers that may be required.

Procedure to Be Used When Adding Two or More Layers

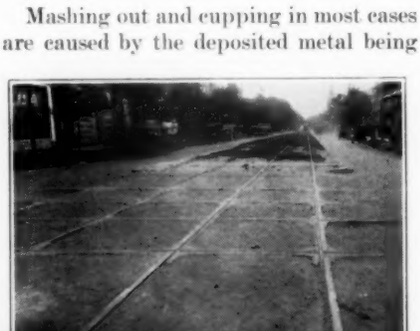
On surface welding of castings where more than two or three layers are required, it is advisable first to build up the worn sections. Where more than three layers are deposited, there is a tendency for check cracks to appear due to contraction stresses which are characteristic of high manganese steel.

A successful method for building up the surface of worn castings requires two different types of electrode, one being a coated chrome-nickel rod and the other a regular high manganese rod (coated). The chrome-nickel rod is used to make the first layer on the worn surface of the casting, and the high manganese rod is deposited on top of this. Both of these electrodes are available on the market. The chrome-nickel is of a standard analysis, commonly called "18-8," with a carbon content around 0.16%. The high manganese rod should give a hard as well as a tough deposit; the metal when laid down has a Brinell hardness of about 225 and after work-hardening will show around 350 to 375.

Failures of various kinds have occurred in the building up of worn surfaces of high manganese castings. The mashing out and cupping of the deposited metal is not infrequent, small pieces have been known to break out, and sometimes the entire deposited section has broken loose.

Causes of Mashing Out and Cupping of Deposit

Mashing out and cupping in most cases are caused by the deposited metal being too soft or numerous blow holes being present due to improper welding. The breaking off of small pieces usually can be traced to check cracks or poor fusion. The breaking out of the entire deposited section can be attributed to several things, but the writer's experience leads to the conclusion that it is caused by the depositing of the electrode directly upon the worn surface of the casting. This worn surface, which was originally a tough, ductile austenitic structure, has been changed to a hard, brittle structure with very little ductility, and when the metal is deposited directly upon it the possibility of the deposited metal breaking out is considerably increased.



Street-Railway Corners Built Up by Welding.

This worn surface can be removed by grinding, but recent developments have shown that by the use of the coated chrome-nickel rod grinding is not necessary. This electrode is used as the first layer, and is deposited directly upon the worn surface. The same technique is used as previously explained for the manganese rod. This material apparently forms an alloy with the hard surface and, with the manganese rod for the wearing surface deposited on top of it, gives excellent results and eliminates the breaking out of the deposited metal.

Grinding Off the Finished Weld

With the welding completed, the grinding is to be considered. This is very important, as poor or careless grinding can be the cause of a short life of the repair. The small portable hand grinder can be used if necessary, but a more satisfactory job can be done by using a regular track grinder designed for this type of work. A straight edge should be frequently used during the grinding operation.

To Give Talks on Welding and Metal Spraying

At the meeting of the Chicago Section, American Welding Society, to be held in the Allerton Hotel the evening of April 21st, E. Wanamaker, of the C. R. I. & P. Railroad, will read a paper on "Railroad Welding Yesterday and Today," which will deal with maintenance welding of rolling stock and of track. This will be followed by a talk on "Metal Spraying" by K. D. Falk, who has had eight years of practical experience in this field and has handled the "gun" on many of the metal-spraying jobs done in the Chicago district. Following his lecture, Mr. Falk will give a demonstration of metal spraying of bronze, iron and other metals. A dinner at 6 p. m. will precede the meeting.

The meeting of the Chicago Section on May 19th will be devoted to pressure-vessel welding, for which a special program of papers is being prepared.

Gas Welding in a Railroad Shop

■ By L. H. SCHEIFELE
Reading Company

Paper read before the International Acetylene Association Convention, held in Philadelphia, Nov. 16-18, 1932.

IN THE locomotive and car shops of the Reading Company, we are charged with the mantenance of 977 locomotives, 1054 locomotive tenders, 44,444 freight cars, 954 passenger cars and 839 miscellaneous cars.

To maintain this large amount of equipment in good running order is no small task. It is essential that repairs be made in the shortest possible time and with the least amount of cost. The various units enter the shops for repairs and are booked to be discharged on a certain date. The number of man-hours required per unit has gradually decreased. Oxyacetylene welding has played no small part in this reduction of man-hours. In addition to reducing the time required on various operations, it has also resulted in savings of capital outlay for new parts, by reclaiming parts which were scrapped prior to the use of this method. Many items are built up to standard size before they have reached the scrap stage, and in this manner they increase considerably the normal life of the part.

Repairing Broken Locomotive Frames

The first major application of oxyacetylene welding at the Reading shops was on broken locomotive frames. I can recall when a broken frame was a major repair operation. It required removing the frame entirely and trucking it to the Smith shop, where it was heated in an old-fashioned coke fire and welded by hand or in some cases, under a steam hammer. This was very costly and caused considerable delay in discharging the locomotive from the shop. Next came thermit welding, which was quite an improvement over the old method as a time and money saver, but did not always produce sound welds on account of the difficulty of releasing all the gases produced when the molten metal was poured into its mold, thereby resulting in a porous or honeycombed weld.

About 1920 we made our first frame weld by the oxyacetylene method. The quality of this weld and the short time required to make it was altogether a new experience. After welding, the part was finished to shape without difficulty and to the best of my knowledge that weld is still holding. Since this date to the present time we have made approximately 1650 oxyacetylene frame welds with only three failures. The present cost of a frame weld is approximately 25% of that of the thermit weld and 5% of that of the old hand weld. The workmanship is superior to both of the previous methods.

Welding Boiler Cylinders Saves 25% in Cost

Our next major application of oxyacetylene welding was the building up of broken locomotive cylinders. Prior to using this method, cracked cylinders were repaired by making a pattern to conform to the outside circumference of the cylinder. A casting was made from this pattern, fitted to the outside directly covering the crack, and bolted fast with patch bolts. The crack on the inside of the bore was sealed by first cutting out the crack so that a wedge pocket was formed much as a dentist drills out a tooth prior to filling. Annealed copper rod was then carefully hammered into the pocket. All of this required considerable time and was costly. If the cylinders were completely broken, they were scrapped, which also required considerable time and cost.

In 1920 we welded our first cylinder by the oxyacetylene method. Up to the present date we have welded approximately 200 cylinders without a single service failure. The average present cost of welding a cylinder is approximately 25% of the cost of a new cylinder. There is also a tremendous saving in time.

Miscellaneous Applications of Welding

Another major application is the building up of worn main pistons. When the circumference of the piston becomes worn to condemning size, it is still further reduced in diameter by machining. It is then built up with bronze filler rod to a diameter that will permit finishing to standard size. This operation is performed without removing the piston head from the rod. This results in a saving of time and costs approximately 28% of the cost of a new piston.

Coal-stoker elevator screws are reclaimed by welding strip steel on the face of the screw. The cost of this operation is approximately 30% of the cost of a new screw.

Car axles which were previously scrapped for lateral journal wear are now being reclaimed by building up the collar on the outside of the journal, to standard size. The cost of welding is approximately 30% of the cost of a new axle.

At the present time we are making a study of welding firebox sheet by the oxyacetylene process. The actual welding time for this operation is only 30% of that required by the electric-arc method. However, the cost is greater due to the cost of the materials involved.

I could go on indefinitely and enumerate applications of oxyacetylene welding to maintenance and reclamation projects. Suffice it to say that without exception it has reduced the time required and in most cases reduced the cost over previous methods.

Our first generator plant equipment consisted of two 250-cu. ft. acetylene generators and one 20-cylinder oxygen manifold. The gases were piped to 107 stations throughout the shops. In 1926 a new generator plant was erected. This plant is equipped with four 500-cu. ft. acetylene generators and two 40-cylinder oxygen manifolds. The gases are piped to 254 stations throughout the shops. The plants not only furnish gases for welding but for cutting operations as well.

Selecting and Training Operators

How do we select and train oxyacetylene operators and what are the fundamental requirements? First of all, the operator should possess a reasonable amount of native intelligence or ability to analyze the job prior to welding. That is, he should know what type of metal he is about to weld. He should also take into consideration its design, whether the parts to be heated are all of equal cross-section and what the effect of local heating has on the adjoining parts. If he understands the job this far, he can select the proper welding rod and know how to preheat the parts prior to welding and how to cool the same after the weld has been completed. He should also know or be instructed what the effect of too high a temperature or a prolonged high temperature will have on the parent metal. This point cannot be emphasized too strongly, as we must remember that in an oxyacetylene flame we have a potential temperature of approximately 4500° F. and some investigators have placed it as high as 6000° F.

The operator should be able to move both hands with equal ease at the same time. This is not always as easy as it might at first thought appear. I have seen men who could not adapt themselves to using both hands with equal dexterity, and it always remained a handicap. Their workmanship was not of the same quality and the time factor was invariably greater than their fellow operators who could move both hands with equal ease.

The operator should know or be instructed that in order to produce a sound weld, he must have the parts clean or free from oxidation. He should know what kind of flux to use for various metals and how to use it.

All of the foregoing may appear to be somewhat over-emphasized. The first thought may be, where or how often can you find men who possess these requirements, who would be willing to take up this work? I do not think that many such men can be found. They should be selected with care and then trained by the welding supervisor or someone possessing the necessary knowledge.

Test coupons should be made periodically by the operators to determine their efficiency. The method of determining this efficiency should receive careful consideration. I have found the following method to be quite satisfactory:

Boiler plate is scarfed to a 60° angle and welded together, leaving the weld slightly higher than the sides of the plate. The test coupons are then machined so that all four sides are parallel. They are then stressed to failure in a universal tensile testing machine, the yield point, ultimate strength and elongation being noted. Up to this point there is nothing unusual about this test method. However, there seems to be considerable difference of opinion as to what constitutes efficiency in a weld. Personally, I feel that an average percentage of the three quality factor percentages of yield point, ultimate strength, and elongation is a good criterion of weld efficiency. The quality factors can be established by taking the average tensile properties of four solid test coupons made of the boiler plate used for weld test coupons. For example, let us assume the data in the following table:

After making a number of tests, you can decide what efficiency percentage is desirable for your work.

In the light of our present day knowledge, thanks to those who patiently pioneered in this work, we understand the basic principles of heating and cooling metals. Possessing this knowledge and equipment to properly use it, we can understand that the pioneers in welding had very little chance of producing satisfactory welds consistently. Not having had our present day knowledge, we might well marvel that they had any appreciable degree of success at all. It is well at this time also to remember that they had some advantages in their favor which we do not always have. Their metals were very low in carbon content and they knew nothing of alloys, simple or complex. Neither was the time factor or cost of the weld particularly important. Today we are called upon to weld all grades of plain carbon and many types of complex alloy steels by various methods. The various methods are all subject to the same physical laws in a greater or lesser degree. The welding of non-ferrous metals was practically impossible until recent years, when the development of oxyacetylene welding made it practically and economically possible.

Effect of Heat on Expansion

Most people are under the impression that when a ferrous or iron base metal is heated, it expands directly in proportion to tthe increase of temperature. Unfortunately this is not the case. Metals have critical points and critical ranges which vary according to their chemical composition. When a given metal is heated it expands gradually until its critical temperature point is reached. Further application of heat will produce no further expansion until the metal heated has passed through its critical range. On the contrary, while passing through its critical range it actually contracts. When this range has been passed it will again expand. The reverse of this phenomenon takes place when cooling a ferrous metal from a temperature above its critical range. The higher the carbon content of the metal, the more pronounced is this phenomenon.

Metals can be heated too rapidly or held too long at elevated temperatures. Most forgings and castings have originally had some form of heat treatment to refine the grain structure. In general a refined or small grain size is desirable, as this condition imparts hardness, strength or toughness, and sometimes varying degrees of all three.

If a ferrous metal in one or all three of these states is heated to a temperature beyond its critical point, the effect of the original heat treatment will be lost, and if possible the part should again be heat treated to restore its original physical properties. If a ferrous metal is held at a temperature well beyond its critical point for a prolonged period of time, grain growth is produced; that is, the original small grains grow into larger ones. This condition is undesirable, as it produces brittleness and lowers the fatigue value or normal life of the part. If grain growth progresses far enough, it is difficult to entirely eliminate it by a single heat treatment. The higher the carbon content and the more refined the grain structure, the more pronounced these effects of heating will be.

Knowing these various physical laws, we can now readily appreciate that considerable judgment must be exercised when heating and cooling ferrous metals. The more irregular or intricate the design, the more care and skill will be required to prevent cracking. All of us have seen, at some time or other, a tool cracked during the hardening process. Quite frequently this cracking is due to improper heating or cooling at or through the critical point.

The higher the carbon content of the metal, the more pronounced will be the effect of heating from a hardenability standpoint. Metals of higher carbon content than are usually found in common structural steels, should be heated slowly to prevent cracking and cooled very slowly to prevent hardening.

All the foregoing are controlled by fixed physical laws which we must obey if we would successfully heat or cool ferrous metals without developing unnecessary expansional or contractional stresses, which may cause breakage. Understanding these laws, we can now see how important it is to carefully preheat a part prior to welding, also why precaution should be taken not to cool it too rapidly.

Aeknowledgement and thanks are due C. A. Gill, superintendent of motive power and rolling equipment, also W. L. Rice, superintendent of locomotive shops, and G. L. Young, boiler foreman, for accecss to their files. The data obtained from these files assisted very materially in preparing this paper.

Average Tensile Properties or Quality Factors

Yield Point, P. S. I.	Ultimate Strength, P. S. I.	Elongation, % in 2 in.
36,225	58,825	40.6

Tensile Properties of Weld Test Coupon

35,500	58,200	26.5

Percentages of Efficiency Based on Quality Factors

98%	99%	63%

Efficiency of Weld

87%

DETAILS of repairs on a coal-fired kiln, engine crankshaft, castings of various types, corroded pipelines, and a pulverizing-mill die ring are cited in this article, abstracted from a paper read before the Second Annual Welding & Heat Treating Exposition, held December 3, 1933, in Minneapolis, Minn.

■ By J. E. COLBERT
Commercial Gas Company

Arc Welding in Maintenance Work

MY SUBJECT is electric arc welding as a repair or maintenance tool, whether used in a job shop or by an industrial.

Many reasons could be advanced in favor of arc welding and without conflicting greatly with its sister trade, gas welding, for they go hand in hand. Possibly the greatest factor in favor of electric welding would be reduction of expansion and contraction by the localization of the heated area. Many other things could be considered of vital importance in favoring arc welding. Time, though it does not hold good on all jobs, is, in most instances, appreciably reduced by electric welding. Cost of operation is also a vital factor to be considered.

Repairing a Cracked Cement Kiln

These remarks are borne out by a few typical jobs with which I am familiar. First, there was the welding of a rotary cement kiln at the plant of a large cement company in Kansas. This kiln is about 10 feet inside diameter, over 125 ft. long, and made from 1½-in. plate and of riveted construction. It was lined inside with fire brick about 6 in. thick, fired with pulverized coal, and had to withstand a heat of nearly 1500° F. at the stack over 125 ft. from the firing nozzle. From this you can gather an idea of the strain this steel cylinder is subjected to, even though supported every 30 ft. on large rollers.

A crack occurred almost in the center of one of these sheets of 1½-in. steel and progressed around it at the rate of over an inch per day until it had become over 4 ft. long. In the meantime the kiln remained in operation while the mechanical brains got together to figure out how to stop it. Patching would only weaken the sheet, which no doubt was already strained by the drilling of rivet holes, and in all probability would not stop the crack from continuing on past the patch.

Arc welding was decided upon. The kiln was stopped and the clinker pulled out, and, when cool enough for the workmen to work inside in asbestos suits, the fire bricks were removed back of the crack. Sand blasting was used to thoroughly clean the outside of the sheet and thereby assist in locating the ends of the crack. Here pilot holes were drilled with a ½-in. drill followed by a 1½-in. long-taper drill.

The oxyacetylene cutting torch was brought into use to cut along the crack and make a 60° bevel from one drill hole to the other. Again the surface of the cut was sand blasted, and welding started at the drill hole. To eliminate arc blow and oxidation of the bottom beads of metal, copper backing plates were clamped inside by welding shop-made C-clamps to the shell of the kiln. A low-carbon bare rod conforming to the American Welding Society E No. 1B was used. Beads were laid longitudinally side by side for perhaps 2½ in. until a layer was formed, then a 40-lb. hammer was used to peen the weld thoroughly. Another layer was laid from one side of the vee to the other across this first layer and likewise peened, etc., alternating from one end of the crack to the other until finished at the center. Then a light wash bead was run continuously on the inside and peened flat. Thirty minutes after the welding was completed, the bricks were being replaced, and within 16½ hours total elapsed time the kiln was again in operation. To my knowledge, it operated over three years after this job without showing any signs of failure.

Uses a Welder as Rebuilding and Hard-Facing Tool

Since that time, this company has used its arc welder for many purposes, such as rebuilding and hardfacing lugs on limestone crusher rolls, rebuilding a gyratory crusher mantle, hammer-mill hammers, and so on. Later a tremendous saving was realized by this concern in the manufacture of their own screw conveyers. This was done by buying high-carbon steel strips twisted to dimension and inserting standard pipe, instead of shafting, and welding with the arc.

It was also my pleasure to do what I believe to be the first hardfacing job ever done on a Hercules mill die ring used in the final pulverizing of commercial portland cement in most plants. This job was done several years ago at a large cement plant in Oklahoma, and is now common practice, being done, I believe, by the manufacturers before these rings leave the factory.

The ring was 6 ft. inside diameter, 2½ in. thick and 6½ in. wide. Originally these were made from manganese steel or high-carbon steel and treated for hardness, lasting on an average of 1100 hours of grinding, with a corresponding decrease in efficiency until becoming too badly worn and pitted for further use.

Hard-Facing a Die Ring Saves $400

Facing was done in about 11½ hours, using ¼-in. Stoodite rod, layed in flat beads 1 in. wide across the inside face, and alternating on each quarter of the ring with five beads in each place, without warpage. The life of this ring was increased to over 5000 hours, and the ring was then rebuilt with high-carbon steel rod and surfaced, thereby effecting a saving of over $400 in the purchase of a new ring, less hard-surfacing.

Many pounds of steel in the form of shafting finds its way into the junk heap every year which could be reclaimed at a very small cost, compared to renewals, by building up with the arc and machining. Spider shafts on Hercules mills, just mentioned, which carry the heavy chilled cast rolls, wear quite rapidly and require frequent replacement. These can be machined to a uniform under-size to remove glaze caused by excess wear in contact with bronze bushings, and rebuilt with the electric arc, using a fast-flowing positive electrode especially designed for this particular type of work, then machined to size and put back into service. Now, in many instances, these shafts, which are about 6 in. in diameter and have a bearing surface of nearly 2 ft., are coated with a hard alloy overlay and ground to size, thereby increasing their life from three to seven times.

Another typical electric job which almost defied the use of any other method of welding was the repair of a broken crankshaft in a 500-hp. Fulton Diesel engine in use in a municipal light plant in Louisiana. This shaft was 9 in. in diameter and broken through one side of the No. 3 crank diagonally through the round section of the shaft.

The crank case was opened thoroughly for ventilation, drained and swabbed out. All connecting rods and pistons were removed and the main bearing caps loosened slightly. The oxyacetylene cutting torch was used to bevel out the broken shaft and crank arm. Then the cut was thoroughly roughed with an air hammer to remove all remaining scale. Precision instruments such as straight edges, micrometric recording surface gages, and fine tool trams, were used to accurately align this shaft while still in position in the journals.

Details of Procedure for Welding Crankcase

Welding was started and continued without interruption until the job was completed. Layers of uniform thickness were deposited on alternate sides of the shaft and crank arm. Each of these layers was thoroughly peened before an additional layer was laid on top of it. During the entire job the current controls on the welder were not changed. Light-coated 3/16-in. electrodes, with a carbon content of 0.25 to 0.35, were used throughout.

The total time required to prepare and complete the welding job was just slightly over 35 hours. When finished and cooled, the shaft was found to be about 0.035 in. off, and a few blows with a light sledge hammer soon corrected that. This shaft is still in operation, although the officials were doubtful enough at the time to order a new shaft, and may still have it on hand.

Cast iron with the electric arc presents some perplexing problems, and almost every one concerned with the advancement of electric welding is wide awake to any ideas that may be forthcoming from any source regarding procedure and results. As in the case of steel welding and the welding of non-ferrous metals, new and better electrodes are being developed almost daily for use with the arc on cast iron.

Cracked water jackets in automobile blocks and other combustion engines present no serious problems to the average arc welder, using any number of the various especially designed rods on the market for this work. The desired result is a water-tight job, which is comparatively easy considering the fact that the casting has to withstand little or no strain.

The principles of fusion welding of cast iron with the arc do not differ greatly from those in using the oxyacetylene method, for the cast iron must be brought to the molten state for fusion welding, and unless free to move, preheating is necessary to assure any degree of satisfaction.

Some welders claim the ability to do a satisfactory job on malleable iron with the arc and, I believe, some concerns are making an issue of this fact in their advertising of their equipment or workmanship. However, by all metallurgical theory and engineering practice, it isn't satisfactory. A common idea among these welders is either to bevel out or put the pieces together without beveling, and, where beveling is used, to fill the vee with a low-carbon steel electrode of average diameter, then change to smaller electrodes and reinforce over the weld, tying in on either side to the steel skin of the casting. However, this is impracticable if only for the reason that reinforcement to such a great extent tends to weaken rather than strengthen any weld no matter what the base metal may be.

Studding is still being used to a great extent on cast iron where strength is required, and fair success can be expected where care is taken not to set up too great an amount of heat by either too fast welding or too much welding in one place.

This method is also practicable on large malleable-iron castings where it is desirable to use the electric arc instead of dismantling and preheating and using the acetylene method of bronze welding.

A typical job of this nature was one done several years ago in an Oklahoma oil field on a large reduction-gear housing made from malleable iron used on a 300-hp. Waukesha gas engine driven rotary oil-drilling rig. This housing was roughly cylindrical, being shaped much like the automobile transmission. It was about 3 ft. in diameter and the metal shell was approximately ½ in. thick. It was cracked from where the main shaft extended out of the housing up to almost the top center of the casting.

Welding Malleable Iron Gear Housing

Staggered holes were drilled on either side of the crack in double rows and ⅜-in. studs were used. The crack was not beveled out. Welding was started at the top, using ⅛-in. G-E type "A" rod, and progressed in beads from stud to stud across the crack and back and so on until completion. The weld was simply a pad superimposed upon the casting and tied together thoroughly by the studs. This housing had to withstand terrific strain and vibration and did withstand it very successfully, being used last year on a test well in western South Dakota some four years after the job was originally done.

Many miles of pipe line that were thought to be unfit for further service have been put into use by patching with the electric arc. Leaky screw fittings such as collars, flanges, etc., can be caulked and welded with the arc. Eroded and corroded patches on pipe can be located either by sight or by hammer test and patched with the arc. An interesting experience was the stopping of a pin-hole leak in a corroded 6-in. pipe carrying oil at 500-lb. pressure. This repair was accomplished without any shut down of the pump or delay of any sort on the pumping equipment.

Stopping a Pin-Hole Leak in Pipeline

A small drift punch was driven in the pin-hole leak and removed. A small round hardwood plug was then whittled out and driven in the hole formed by the punch. This plug was sawed off flush with the pipe and a small patch of the same contour as the outside diameter of the pipe was fitted to the pipe, and was of such size as to cover the corroded space or area. This patch was then electric welded around the outside, using a fillet weld, thereby forming a satisfactory leak-proof patch. This method would also hold good on almost any sort of pipe line carrying almost any sort of liquid or gas.

In many states where the boiler laws permit, flues are electrically welded to the flue sheet, thereby effecting a permanent leak-proof job. This forms a very lucrative source of revenue to the wide-awake shop man who is out after business regardless of whether the flues are in need of repair or not.

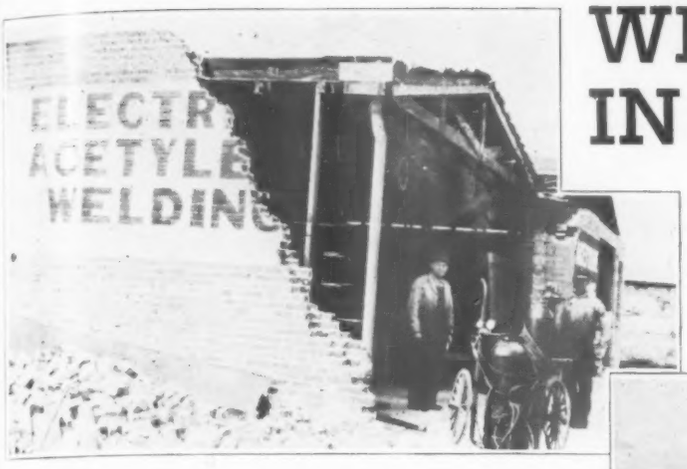
First British All-Welded Factory

The first factory of the Bata shoe combine in the United Kingdom has just been completed at East Tilbury and has been constructed entirely by electric arc welding. In Zlin, Czechoslovakia, where the combine has its headquarters, all-steel-frame buildings are now constructed without the use of rivets or bolts by means of arc welding, and the adoption of this method of construction has enabled a saving of 11% to be made in the weight of metal used.

The British factory is an exact replica of the one in Zlin. It is 260 ft. in length and 62 ft. wide. It comprises 56 stanchions and 14 trusses. The stanchions are constructed of 3⅞x2x¼-in. channels, and the roof trusses of 2¾x 5/16-in. T-bars. The lattice bracings on the trusses are 1½x7/32 in. All-steel windows are fitted throughout and are all welded into the main framework.

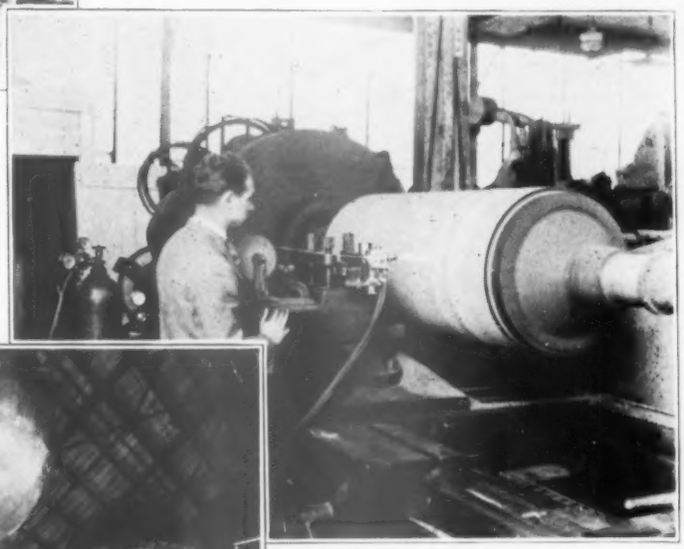
The building was erected in five weeks from the turning of the first sod.

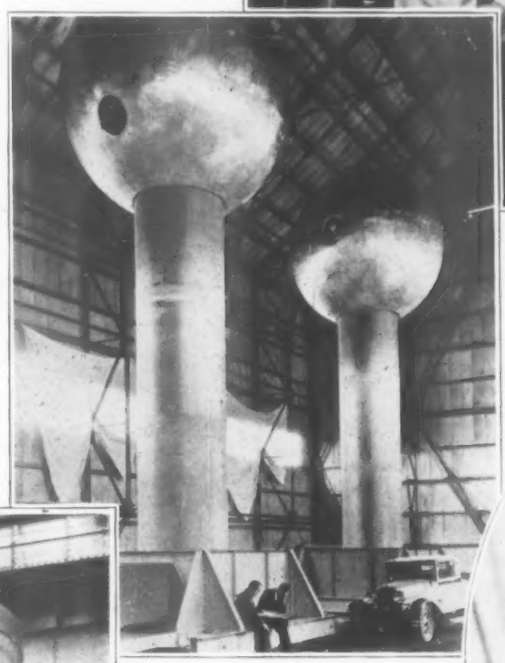
WELDING NEWS IN PICTURES - - -



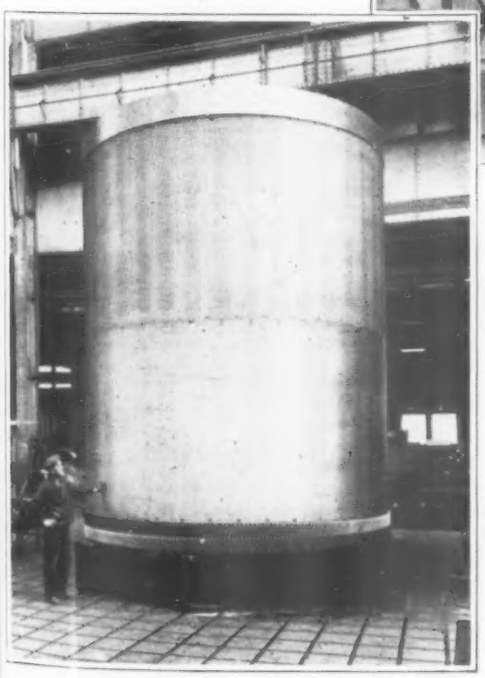
"Business as Usual!" With gaps in the walls caused by the recent southern California earthquake, J. W. Helm & Son, of Compton, Calif., announce that they're "still doing business at the old stand."

Building up a 30-in. paper roll by "metallizing" stainless steel. This roll, 8 ft. long, was undersize. Before adding the metal, the roll was machined, permitting the tool to chatter, instead of roughening the surface by sandblasting. The gun, mounted on the carriage of a lathe, sprays the molten metal onto the roll. Later the roll was machine ground to a high finish.

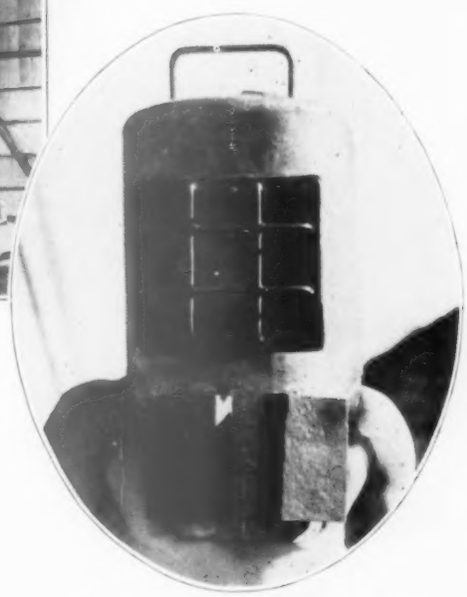




This apparatus, containing two arc-welded aluminum spheres 15 ft. 6 in. in diameter, will deliver 10,000,000 volts of electrical energy and will be used by the Massachusetts Institute of Technology for exploring the secrets of atomic energy. The spheres were built by the Chicago Bridge & Iron Works, using equipment and aluminum electrodes furnished by the Lincoln Electric Co.



This arc-welded lifting-hoist drum will be wound with more than a mile of 1⅛-in. wire rope. This drum, and another like it, are built for the cableway now under construction at Hoover Dam. Each drum weighs 90,000 lb. and is rolled from steel plate 2 in. thick, 42 ft. long, and 8 ft. wide. The seams and internal strengthening structure were welded with General Electric welders and electrodes.



All-welded diver's helmet made by a student at the Wiggins Trade School, Los Angeles, Calif., from an old domestic water-heater tank, with steel weights welded on the bottom, welded-in bars for glass guards, and including air-line connections.

Pipe Welding

Observations on Testing and Supervision

By JOHN J. CUMMINGS

On practically all large pipe jobs the welders are required to pass tests before being permitted to work. The welding supervisor and engineer of tests are to some degree responsible for the results of such tests. Cases have occurred where the welder applicant has been unjustly penalized and his average has failed to pass him owing to oversight or neglect on the part of the supervisor rather than any deliberate intent.

It is to the interest of the contractor that he have his welding supervisor make a thorough inspection of apparatus, provide adequate torch tips, see that a two-stage reduction is provided in the oxygen line, which I think should be required, and have all preparations made at least one day in advance of the test. The supervisor should allot the apparatus to each man and not allow any "grab-bag" game to take place. The engineer of tests should be in complete charge.

Onlookers should not be allowed to pass any judgment and especially to offer suggestions or give instructions, because, however well intended such a gesture may be, it can cause the man to be disqualified and not allowed to go on with the test, which would be an injustice to him.

Inasmuch as there is a great variation in the types and dimensions of welds made by even the most experienced welders, it would seem that much of value could be accomplished in encouraging the adoption of a standard weld dimension. The test most used is the one recommended by the National Piping Contractors Association, so would it not be advisable to adopt their dimension of $2\frac{1}{2}$ times the wall thickness as the desired weld width? It matters little whether the reinforcement be $\frac{1}{8}$ or $\frac{1}{4}$ in. high, because this surplus is machined off anyway.

A difference of opinion exists as to the value of adopting a definite standard and requiring all welders to work to that standard, but my experience leads me to believe that a specification on weld dimensions is sensible and proper. Where a number of men are employed on a job, it is much better to encourage them to work to a definite, adequate standard than to have an exhibition of more or less superficial skill which has nothing whatever to do with insuring the integrity of the weld but does succeed in upsetting uniformity and cost factors.

The majority of welders are willing to cooperate in matters of this kind, and success in getting them to do so rests largely upon the definite adoption of the idea and the type of man employed as supervisor.

Many engineers express grave concern over the matter of insuring the integrity of a weld, because the fact is obvious that inspection alone won't do it. Certification by test, and experienced supervision, not just technical supervision, will do it; this of course involves supplying proper apparatus and rod material, and it challenges the fairness of allowing men with no background of welding knowledge or experience to supervise or inspect the work of mechanics who are certified by test to do the work.

One of the common faults found in testing is the lack of penetration. A notch or double notch at the bottom of a welded test coupon casts suspicion on all welds made by the same workman, as does also a recess on an overhead weld. Most pipe welders are inclined to put most of their effort into producing a "slick-looking" job, the reason being mainly that their work has been judged from this point of view by those who have not acquired the ability to judge the character of welds in any other manner, but who may have the authority to hire and fire.

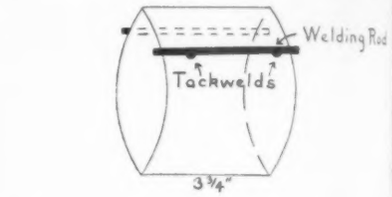
There is a rather simple but effective plan of welding which will insure uniformly complete penetration. With the pipe properly pinned and about $\frac{1}{8}$ in. separation maintained, the welder starts at one pin and back welds or stitches the bottom edges together until he arrives at the next pin. Then he reverses and goes forward, filling in as required. This simplifies the joining of extra-heavy pipe in all positions of welding.

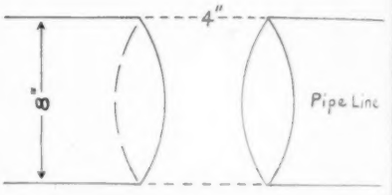
Kink for Welding Nipple Into Pipeline

By W. A. VOSS

Where a short length of pipe or a nipple is to be welded into a line, the diagram shows a very simple method for holding the nipple in place for tacking and welding. This method is applicable where an old flange is cut out of the pipe and a nipple is to be inserted and welded in the place of the flange.

After cutting the leaky flange out of the pipeline with a torch, the welder cuts a nipple $\frac{1}{4}$ in. shorter than the opening left in the line, thus allowing a space of $\frac{1}{8}$ in. on each end of the nipple for expansion while welding. He then tack-welds two rods (welding rods can be used) on the side of the nipple as shown, so the ends of the rods will project about an inch over each end. Then the nipple





The Nipple Is Held in Position by Rods Before Welding.

is put in the line, with the projecting ends of the rods bearing on the pipe. The rods will hold the nipple in place while the welder tacks it in the pipeline.

The nipple is then welded in place, starting on the bottom and welding up to the top of the pipe, then starting on the bottom again and welding up the other side. The rods are removed during the welding operation.

Shipbuilding

Welding to Thwart the Teredo Navalis

Shipbuilding history in the realm of the sailboat is being enacted at the plant of the Marblehead Metal Boat Co., of South Boston, Mass. For the first time in the long annals of sailing vessels, a sailboat is being built which will resist attacks from the destructive shipworm, teredo navalis. The feat will be accomplished by constructing this boat of fabricated iron plates, welded together.

To get the better of the shipworm is one of those grand achievements which is likely in time to entirely revolutionize methods of ship construction for small sailing craft. From Maine to Florida, up and down the Atlantic seaboard, the voracious and prolific teredo, in one species or another, has its hunting grounds. These mollusks bore tunnels in wood of all

View of Sailboat, Showing Welding Details.

sorts, even the hardest varieties. The tunnels which they make range from 5 in. to 5 ft. in length and have a maximum diameter of 1⅛ in. Consequently the wood is soon perforated until it is in a honeycomb condition and is rendered useless for human utility. Ships with wooden bottoms have eternally been exposed to this problem, and until now most small crafts have been built of wood.

The new vessel is being constructed from designs by Robert W. Rose, naval architect, of Marblehead. The owner is Samuel B. Jones, Jr., of Marblehead, who will sail the new craft this spring in Massachusetts Bay. The wood-boring shipworm will find a disagreeable surprise in store for him when he endeavors to take up his abode in the steel sailboat for he will merely flatten his snout to the point of soreness if he tries to tunnel through the iron bottom of this welded boat.

Sixteen-gage plates are being used in welding the vessel, which is also provided with a ¼-in. plate rudder and centerboard. The plate edges will be butted together on an iron pipe frame and fused into a solid watertight joint with a General Electric arc-welding set.

The boat will be 16 ft. long, and will be supplied with iron pontoons, which will contribute sufficient buoyancy to lift the boat in the surrounding water, in case of rough seas, so that any water which may have been shipped will flow back into the sea through a sea-plug in the bottom of the hull. In case the boat is capsized, she may be easily righted by means of one man's weight applied against the centerboard. Under normal conditions, owing to her absolutely dry bilge, she can be used for storage.

Another boat of similar construction is contemplated, and if the anticipated success in sailing these two craft materializes, wooden sailboats around Massachusetts Bay may be nearing the end of their voyage.

Welded Cargo Vessel Uses Reverse Channel System

How welded construction effects reductions in shipbuilding and operating costs, and lessens time required for construction, is aptly illustrated in the recently launched steel self-propelled cargo vessel *William F. Kenny*, and in the Berwind White Coal Mining Company Barge No. 100, both of which utilize the patented reverse channel system of fabrication developed by Johannes Kjekstad, consulting engineer, United Dry Docks, Inc. An outstanding feature in the design of these vessels is reduction in gross hull weight by eliminating approximately 90% of the number of ribs usually used in such vessels, with a resultant substantial increase in cubic capacity.

The all-welded, steel Diesel-driven cargo ship *William F. Kenny* will displace the bulk-cargo wooden barges formerly employed by the owners, the New Jersey Clay Products Co., Inc., in coastwise service between New York, Washington, and other Atlantic ports, carrying cargoes of hollow building tile enclosed in steel containers, thereby effecting large operating economies, including an estimated reduction in tile breakage exceeding 6%.

In the construction of the *William F. Kenny*, 12-in., 60-ft. channels were welded into complete hull sections, and the sections were then lifted into place and welded together to form the complete bottom, sides and deck of the hull. The amount of welding approximated 60,000 ft. The channel sections in the bows and the stern were formed by rolling the individual channels before welding them together, in an ordinary plate roll, to the necessary curvature. The vessel, of 1220 net tons capacity, 185-ft. length, 43-ft. beam, and 9½-ft. draft, was constructed at the Staten Island, N. Y., plant of the United Dry Docks, Inc., and launched on February 28th. Henry J. Gielow, Inc., were employed as the owner's naval architects.

The reverse channel system of construction, according to Johannes Kjekstad, the inventor, who will be recalled as the originator of the Truss-Weld system previously described in THE WELDING ENGINEER, provides the high degree of rigidity and longitudinal strength necessary to long, shallow vessels. In this design, the webs of the channel are placed in opposed position and the flanges electrically welded, and the maximum percentage of weight is converted into effective longitudinal strength. The weight of the shell plating is claimed to be six or more times the weight of the internal structure, with a moment of inertia far in excess of any other type of construction of equal hull weight.

"The section modulus of the reverse channel section is six times greater than that of a channel section placed with the webs in the same position, but this tremendous increase in strength is relatively unimportant as compared with the

View of Welded Cargo Ship After Launching.

numerous other advantages of the design," states Mr. Kjekstad. "The flanges of the channels overlap each other to form a lap-welded seam, which is located in the neutral axis of the section and therefore subject to minimum stress. The lap weld eliminates warping and locked-in stresses, which frequently cause failure in butt-welded sections. Another feature of this design, which may sometimes prove invaluable, is the tendency of the section to stretch out transversely, in the manner of an accordion, rather than to fracture, as in the case of plate or other types of flat surface construction, should a collision or grounding occur. The reverse channel system produces a shell plating which is stiff enough to obviate need of much additional stiffening; many times in actual service it has demonstrated its rugged resistance."

Following six months of continuous service, when the all-welded 130-ft. 1200-ton-capacity Berwind White Coal Mining Co. Barge No. 100, was docked for customary painting, concrete evidence was afforded of the strength and reliability of the welded construction. Because of subjection to severe abuse from unloading by clam-shell buckets weighing five tons and filled with coal, the reverse channel bottom, 35 ft. by 110 ft., is covered with a $\frac{3}{8}$-in. inner plate bottom. In the case of riveted construction, a space similar to that existing between the channel bottom and the plate bottom is subject to corrosion. To eliminate this possibility in the present case, air was exhausted in this space to a 22-in. vacuum. Although there is approximately 20,000 linear feet of welding in this section, and the presence of the minutest pinhole would have destroyed the vacuum, inspection following the six months of hard service found the vacuum to have been fully maintained.

(Courtesy Marine Review)

Profile Plan of the William F. Kenny.

On March 30, 1933, almost a year from the date of launching of Barge No. 100, a survey of the vessel was conducted by Capt. Leroy A. French, marine superintendent of the Berwind White Coal Mining Co. A part of the plate bottom was cut out and the section that had been purposely left unpainted so as to permit a check-up, was found still to possess the original mill-scale and to be free of the slightest trace of rust. The barge had carried approximately 80,000 tons of coal during the year's service; the survey showed the vessel to be entirely free of any structural defects following this exacting performance. A 50% increase in service life, in addition to 40% savings in operating costs, is anticipated as compared with wooden barges.

Bridge Repairing

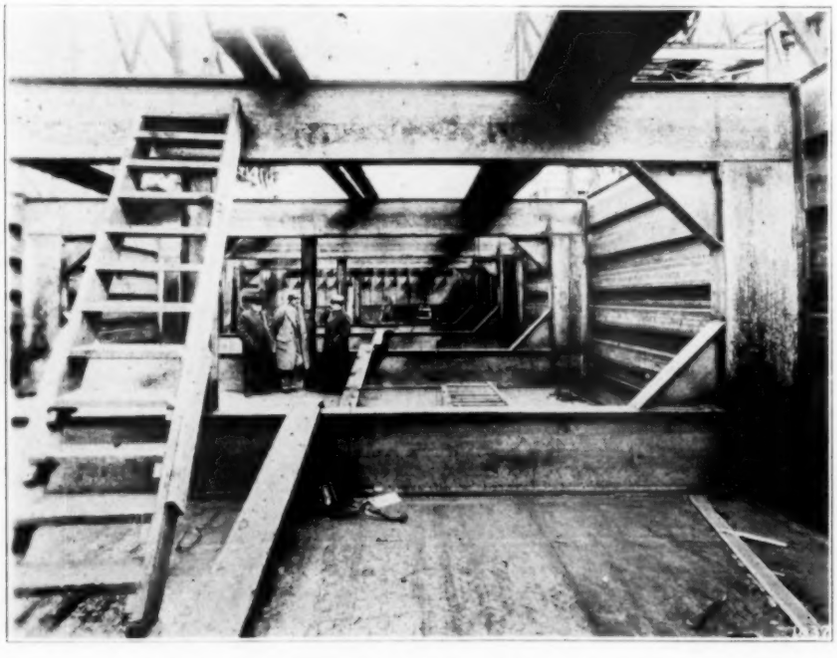
Cross Girders Welded to Railroad Bridge

A particularly interesting example of bridge reconstruction on a line carrying heavy traffic was recently completed at South Tottenham, on the London Midland & Scottish Railway. The work was carried out to the designs of A. Newlands, chief civil engineer.

The bridge is a three-span, double-track, continuous-girder structure, 190 ft. long, with plated deck and longitudinal lumber way-beams carried by steel joist stringers. The main girders were sufficiently strong to carry the increased loading that had to be provided for, but the stringers and cross girders were inadequate. Also, the deck steelwork had suffered considerable corrosion, so that replacement of the entire deck was necessary. This work had to be done without any interference with the normal traffic in either direction over the bridge.

The existing cross girders were spaced at 6 ft. centers. New cross girders were designed to fit between the old ones, also at 6 ft. centers, and to be connected to the main girders by new gusset plates, $\frac{1}{2}$ in. thick, welded to the main web plates. It should be noted that the vertical fillet welds on each gusset carry the full end reaction from the cross girder. The gusset is stayed laterally by a horizontal piece of plate welded to it and to the main girder. The new gussets came opposite to T-stiffeners riveted on the outside of the girders, so that a riveted connection for them would have been difficult to arrange. It was considered that the welded connection involved the minimum of interference with the existing structure, besides being more expeditious and economical.

The procedure, novel to Britain, which was adopted in replacing the deck was as follows: During the day the new gussets were set in position and welded, the welders having to stop work and move out of the way when the trains passed. Because of the heavy traffic on this line, about $1\frac{1}{2}$ hr. of welding time per day was lost on account of the trains. Welding, however, lends itself better to constantly interrupted work of this kind than drilling or riveting, since the weld-



Interior View of Welded Hull of Barge No. 100.

ers' equipment—electrode holder and screen—are light and portable, and there is no noise to prevent their hearing the warning of the look-out man. At the same time, the rivets were cut out of the deck plating.

The actual replacement of the deck was done early on a Sunday morning, complete "possession" of the line being allowed from 11:10 p. m. Saturday to 7 a. m. Sunday. A length of track was then pulled up, and the cross girder ends burnt off flush with the edges of the main girder flanges, so that the deck could be lifted out complete, two panels at a time, by a locomotive crane. The new cross girders, stringers, and deck plates were then put in place and riveted up, and the length of track relaid. It was estimated that four panels of the deck—that is, four cross girders—could be removed and replaced during each "possession." Such good progress was made, however, that it was found possible to replace six panels each night. Only five week-end "possessions" were then required to complete the work, instead of eight, as had been originally anticipated. The railroad is highly satisfied with its full-scale experiment with electric welding.

Welding on Roadway Slabs and on Columns

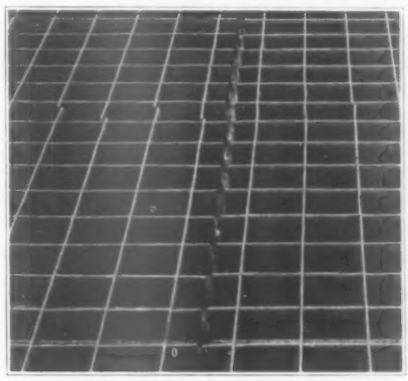
The recent rebuilding of the Oak St. bridge over the New York Central tracks in Toledo illustrated a novel method of reconditioning old bridge structures through the use of arc welding at a low cost. This particular bridge, which had been in service for many years, needed

Plug Welding Steel Slab to Bridge Stringers.

additional strengthening and a new road surface to replace the badly worn double plank flooring.

In order to reduce the weight of the roadway slab and its wearing surface, a new form of slab construction was used, this involving structural tees in combination with lighter flat bars mechanically interlocked with the tees. The slabs, 3 in. deep, were delivered to the job in 4-ft. widths.

The 3-in. tees had been shop welded intermittently between the toes. This, together with the insertion of flat bars into alternating curved slots in the tees, assured stiffness and rigidity of construction. To insert the bars, the stems of the tees were punched at intervals with curved slots, the direction of the slots being alternated in adjacent tees so that the



Roadway Slab After Welding.

bar in being forced into position is twisted in alternate directions in successive tees. This type of construction, called T-Trilock, was developed by the Carnegie Steel Company. Fabrication of the slabs was done in their shops.

The Oak St. bridge is 207 ft. long and 35 ft. wide, with a 24-ft. roadway. Five stringers support the steel slab. Due to the projection of the top flange of the side girders, it was necessary to place the T-slabs in two sections across the roadway, making a longitudinal joint through the approximate center of the bridge. Before delivery to the job, the slabs were punched with holes at the intersection of every third or fourth tee, the holes being so placed as to appear over the center lines of the stringers. After the slabs were placed in position, plug welds were made, utilizing these holes, and thus securely joining the slab to the framework of the bridge. All welding was done by the Hans Hansen Welding Company, of Toledo, using equipment manufactured by The Lincoln Electric Company, Cleveland, Ohio.

Once secured, the slab was filled with concrete, flush with the top of the tees and cross-bars, forming an armored road surface. The steel work was vibrated immediately after pouring to secure concrete of maximum density. The resulting structure is a unit slab of steel cells filled with concrete. Since the tee flanges were placed close together, no forms were necessary for the concrete.

With this type of construction, the roadway slab and the stringers act as an integral unit under stress. Thus additional strength is secured although the dead load is kept at a low figure. The weight of the steel is 21½ lb. per sq. ft., and the entire slab, including the concrete, weighs 52 lb. per sq. ft.

Before work was begun on the flooring, 2600 ft. of welding was done on the column reinforcement. This consisted of reinforcing weakened columns by welding steel plates to the columns, replacing riveted lattice work.

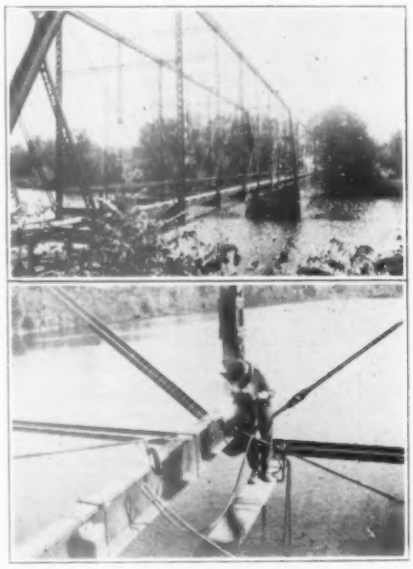
The total welding time was 96 hr. Contractors for the reconditioning of the bridge were The Standard Engineering Company of Toledo, Ohio.

Highway Bridges Repaired by Welding

Rather than replace old bridges or repair them by more expensive methods, engineers are employing arc welding to bring weakened structures to their full load strength.

Two recent construction jobs illustrate this trend. At Buchanan, Michigan, a 410 foot bridge (Fig. 1) was reinforced to provide the necessary strength. The structure, with an 18-ft. roadway, has twenty-one 15-in. I-beams which were reinforced by welding ⅜-in. plate on both top and bottom (Fig. 2).

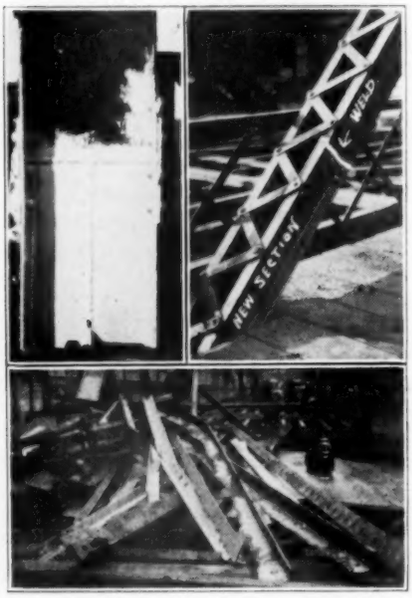
Contractors for this job were the Elkhart Bridge & Iron Works, Elkhart, Ind. The welding contract was sublet to the Elkhart Welding Co. Estimates for welding, using bare electrodes, were based on 7½ hr. welding time on each I-beam. Using shielded-arc electrodes, the actual



Figs. 1 and 2. View of Buchanan, Mich., Bridge, and Welder at Work Welding Plate to Flanges of 15-in. I-Beams.

welding time was 2½ hr. per I-beam. Approximately 1600 ft. of welds were laid, using equipment manufactured by The Lincoln Electric Co., Cleveland, Ohio. This is believed to be the first State specification project in Michigan to be completely welded by the shielded-arc process.

Another interesting bridge repair project was completed recently on Pennsylvania Route 8. On this bridge there were six columns running from the top beam to floor beam and bottom cords. These columns are made from 12-in. channels and would have had to be replaced had it not been possible to repair the defective sections by arc welding. Half of a column was cut out at a time and a new



Figs. 3, 4 and 5. Welded Channel After Painting; View of New Section Welded Into Chord; and Pile of Scrap Removed from Bridge and Replaced by New Steel.

section welded in before the other side was disturbed. All the welds were butt welds, as shown in Fig. 3. Defective stringers and chords were also reinforced or replaced with new sections welded in place, as Fig. 4 shows.

Wisconsin Steamfitters Hold Conference

A conference for steamfitters and Crane Company representatives of southern Wisconsin was held at Madison, Wis., March 24th. The conference was called by Henry Pommerenck, steamfitting and plumbing instructor, who presided over the sessions.

"Panel Heating in Homes" was the subject of a talk by John P. Magos, Crane Co., Chicago, who discussed the comparative advantages and efficiencies of concealed and exposed radiation. W. G. Martin, instructor of sheet metal and welding in the Madison Vocational School, read a paper on "Pipe Welding for Steamfitters," in which he cited ten advantages for the welded installation. Motion pictures on welding and panel heating were shown by Mr. Lee, Linde Air Products Co., Milwaukee. The conference was well attended and high interest was shown.

Bridge Repairing Discussed at Philadelphia Meeting

"Experiences of a County Engineer in Repairing and Strengthening Highway Bridges" and "Modernizing Existing Metallic Bridges by Redecking and Arc Welding," were the papers constituting the interesting program of the March meeting of the Philadelphia section of the American Welding Society. Mr. Harry K. Ellis, County Engineer, Chester County, presented the former paper, with the latter delivered by Mr. Joseph G. Shryock, chief engineer, Belmont Iron Works. "The Influence of Welding on Ship Construction," to be presented by Lt.-Commander A. I. McKee, U. S. N., is scheduled for the April 17th meeting of the Philadelphia section. This is the annual session of the Philadelphia section.

Purdue Initiates 3-Weeks Welding Course

A special 3-weeks course in welding, open to anyone, will be conducted for the first time this summer by Purdue University, Lafayette, Ind., states Prof. J. D. Hoffman. This course is intended for the man who cannot take the time or lacks the finances to afford the usual 8-weeks summer welding course given by the same school. The 8-weeks course will be given as usual. It and the 3-weeks course will consist of a 24-hour week. The class starts at 8 a. m. and lets out at 12 noon. The 8-weeks course is also open to anyone, but is intended primarily for the man who desires to become a welder rather than for the engineer, and therefore the usual requirements of a high school education and a sufficient amount of credits does not apply.

Large Welding Program Under Way

A $25,000 construction program involving a great amount of welding was recently announced by the Golden Bear Oil Co., of Los Angeles, Calif. Part of this work will include the erection and installation of equipment for a road oil plant near King City, Calif. Work on this project will be under way within 30 days.

Receives Contract for Four Welded Storage Tanks

Contracts have been placed by the Sinclair Refining Co. at Houston, Texas with the Chicago Bridge & Iron Works for the construction of four 80,000-barrel welded storage tanks. These tanks, which will also be equipped with Wiggins all-welded pontoon floating roofs, will be erected at the company's refinery at Houston.

Attaches Time Piece to Oxygen Regulator

Eldon Krieg, manager of Krieg & Son, South Whitley, Ind., had on exhibit at the Indiana Ironsmiths and Welders conference held at Purdue an oxygen regulator on which he had fastened a Westclox automobile stem-wind and stem-set watch. When he starts to weld he immediately sets the minute hand to twelve. When he is through and shuts his torch, his watch immediately tells him how many minutes the torch was burning, and by referring to his chart he can tell the amount of gases used and their cost. Also he can let the watch run till the job is finished and tell the total time taken. He claims the watch makes substantial savings.

Reads Paper on Design of Welded Steel Structures

The problems encountered in the designing and fabrication of welded steel structures, and the procedure successfully employed in their solution, were covered in "The Practical Design of Welded Steel Structures," presented by H. M. Priest, designing engineer, American Bridge Company, at the March 23rd meeting of the New York Section of the American Welding Society. An interested audience of more than four hundred attended the lecture, which was profusely illustrated with design charts and tabular material. F. H. Frankland, director of engineering service for the American Institute of Steel Construction, presided.

Large Cast-Iron Rods for Filler Metal

One order which probably holds the record for the size of rod has just been shipped by the Decatur Casting Co., Decatur, Ill. The order called for 600 lb. of cast-iron welding rod, 2x2 in. square and 6 ft. long. This company's cast-iron welding rod business, which started as a sideline, is showing a gradual increase in volume. For the past three months, the company has been operating six days a week to supply castings for general demand.

Los Angeles Trade School Has Welding Course

Thirty-two students are enrolled in the day classes of the welding course in the Wiggins Trade School of Los Angeles for the second semester of the school year. John W. McCartney is instructor in this department, in which is featured all modern procedure in both oxyacetylene and electric welding. Much actual repair work is done by the students in this department.

· E D I T O R I A L ·

Make Welding More Profitable

● If ever there was a time when economies offered by the welding processes should be taken full advantage of by industry that time is to-day. This statement does not imply alone that welding should be more extensively used, but it also means that in those places where welding is an accepted means of fabrication and repair, the welding processes must be used with discrimination, and the proper technique applied to insure the very minimum cost consistent with quality of product. A few years ago any failure on the part of factory executives to obtain a satisfactory welded product in all cases might be passed off by the claim that men who really knew how to make reliable welds and do so economically could not be obtained. Such an excuse as this one will not hold to-day. Welders of long experience—men who can attempt the most intricate job and make a product that has no apparent distortion, and gives long, reliable service—are to-day in need of employment. Such men as these are not plentiful as compared with the total number of employed welders; yet many of them are available to the manufacturer as welders and as welding supervisors and such men are worth several times the rate of pay that most welders are getting to-day. Perhaps the need for competent welding supervision can be brought home by citing several specific instances of how such supervision is worth much more to the manufacturer than what it costs. A certain manufacturer in the Middle West manufacturing a boiler accessory was paying welders 63c an hour and each man was turning out an average of one such accessory per hour. Testers were employed to alternately check, repair, check, repair, and so on, until the resulting product was satisfactory in every respect. The product was of a nature requiring extreme skill in its fabrication, but as it came from the welder it was not at all satisfactory and required so much patching up and checking that these testers averaged only one of these accessories per day. After a competent welder was obtained to supervise the work, each welder was turning out three accessories per hour and the work is so well done that each tester was O. K.'ing between fifteen and twenty per day. The new welder's compensation of $1.00 an hour is an extremely small fraction of the money he is saving his firm. There is a case where a certain manufacturer of milk cans employing welders on a piece-work basis laid down his own rules concerning the set-up of the work and the sequence of the welding operations involved. This was extremely unfair to the welders themselves, as it slowed up production to the place where their average wage was only 30c an hour, whereas if they could set up their own work, they would have averaged $1.25 per hour. The user of welding cannot afford to be near-sighted in his policy toward the welder. When once a welder is obtained who has proved his loyalty, competence, and reliability, full cooperation should be given him in all matters pertaining to welding. Only in this way can the user of welding really take fullest advantage of the process.

Welding at the World's Fair

● Unsurpassed for its grandeur, educational value, completeness of exhibits, and wide-spread interest among the people in all walks of life is Chicago's International Exposition—A Century of Progress—which stretches for three miles along Chicago's lake front and opens its doors in June. During the week of June 25th this will be the mecca for engineers from all over the world. More than thirty engineering and technical organizations are arranging special programs for their members and for visiting engineers, and these will be tied in to some extent with the Fair. The Mid-Western Power Exposition will be held in the Coliseum during the same week and will show many of the latest developments in the generation, transmission and utilization of power. Visiting engineers will have a wonderful opportunity to see practical demonstrations of welding on the World's Fair grounds. Particularly interesting is the fact that welding has been used in the manufacture of such a great variety of structural parts on the grounds and devices on exhibit. The Sky-Ride towers—the dominating structures at the Fair—will be intriguing because of their huge size and their massive welded columns. Prehistoric animals that crane their necks, open their mouths and switch their tails and breathe like the living creatures on this earth a million years ago, will have welded skeletons of steel. A huge globe on display, if carefully examined, will reveal the fact it is made from plates formed to size and butt welded. Welded column plates, welded trusses and other forms of welded framework will be evident in some of the buildings. Welding will be used in the construction of two sample full-size houses. Beautifully polished welded truck tanks will be on display. Welding would have been used even more extensively than it was were it not for the fact that all structures on the grounds are to be dismantled after the closing of the Fair, and it was considered that bolting would facilitate such dismantling and salvaging. Manufacturers of welding equipment will have prominent displays throughout the time of the Fair. The immensity of the Fair will be so great that the casual visitor cannot cover the grounds in only one day. If he should confine himself only to walking on the promenades it would take him twenty-four hours to complete the rounds without stopping to examine anything. More lights will be used in brightening the Science Building alone than were used in the entire World's Columbian Exposition of 1893. All in all, it will be a sight and experience that will never be forgotten and which will probably not be surpassed for at least two generations.

New Equipment

New Method of Electric Welding

A new development in arc welding, particularly suited to the joining of heavy plates, is announced by the Metal & Thermit Corp. Known as Murex Straight Gap welding, the new process does away with all need for veeing or grooving of plate edges. Plates may be used just as they come from the mill. Greater welding speed as well as appreciable reductions in cost are claimed. In fact, this process is said to cut welding time in half, and, by eliminating all preparatory work and reducing the quantity of weld metal required, achieves real economy in welding heavy plates. In addition, it is stated, tests conducted by outside laboratories show that "Straight Gap" welds are physically superior in many ways to those in which the usual V or U gaps are employed. Literature on this process can be obtained from the Metal & Thermit Corp., 120 Broadway, New York, N. Y.

New Welders for Railroad and Highway Service

Two unusual types of arc welders have recently been built by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., one for railroad maintenance and the other for maintenance of highway equipment. The Lehigh Valley Railroad has purchased six of the welders developed for railroad service. This welder is of the crawler type. It is capable of operating along the shoulder of the track entirely clear of trains, and it is said to be able to ascend 35° slopes and to be stable in operation on side slopes up to 45°. The overall width is 30 in., and the tractor measures 36 in. from the ground to the top of the upper tread. The power unit is a 65-hp. Buda engine. The control scheme permits welding and grinding operations to be carried on simultaneously.

The Westinghouse dual-drive welding set, built for the Tennessee State Department of Highways, has several unusual features, one of which is a shaft extension for compressor drive, and another is a V-belt-driven exciter, which is said to assure a very uniform excitation current. A clutch operates a change over from gas-engine to a 15-hp. a. c. motor drive.

New Electrode Refines Grain Structure of Welds

The annealing action of the successive layers in multiple-layer welds is credited with the high quality that characterizes this type of weld. This does not apply, however, to the last layer, which must be annealed independently of the other layers if it is to be of as good quality. A solution to the problem of annealing the outside layers of multiple-layer welds is the normalizing electrode, which has just been announced by The Electric Arc Cutting & Welding Co., 152 Jelliff Ave., Newark, N. J.

Without adding metal, this new electrode obtains the proper refining action very rapidly and at very little cost, states C. J. Holslag, president of the company. The electrode also smooths over the inequalities of the weld and gives it a good appearance. This results, it is claimed, in a glazed covering which allows painting, red leading, enameling, or the like over the weld, without danger of chipping, blistering, and cracking of the paint or other covering. The action of the electrode is said to insure that the last layer of the weld will be of as high quality as the rest of the weld metal.

This new rod entirely consumes itself and can be used to anneal a line across metal for bending, breaking, or wherever a change in grain structure is desired. It machines itself clear.

For vertical and overhead work, it is said to be practicable and especially feasible in producing good grain refinement. It gives the weld deposit an annealing or normalizing action and prevents the usual glass-like hardness.

A wide range in sizes and current capacities are available in these electrodes, and they can be supplied for various types of applications.

Murex Announces New Heavy Coated Electrode

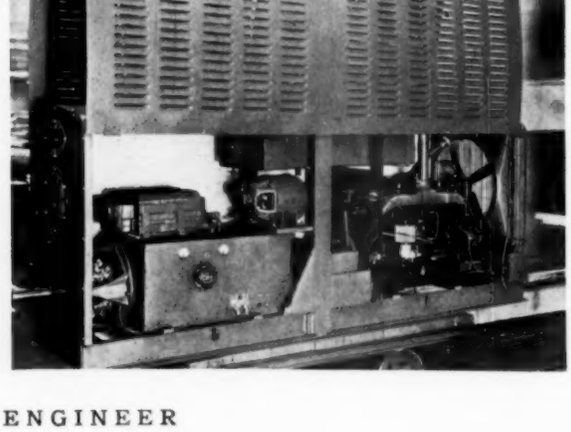
A new electrode, known as Murex Universal, has been added to the line of Murex heavy mineral coated electrodes manufactured by the Metal & Thermit Corp., 120 Broadway, New York, N. Y. This new electrode is for use on mild steel and may be employed in either flat, vertical, or overhead work. Smooth, clean deposits of unusually high tensile strength and ductility are obtained consistently, it is said, on any of these classes of work.

German Welding Rod Has Tungsten-Iron Core

Welding rods composed of alloys of tungsten and iron are very suitable to obtain a tough weld metal having good wear-resisting properties. Such alloys, however, have very high melting points and are generally hard to cast satisfactorily into rods of the length normally used. In an invention just patented in Great Britain by Fried. Krupp A.-G., a tube of iron or similar metal has sintered into it a core of, for example, tungsten carbide, and a metal of lower melting point such as iron, chromium, etc. The composition of the rod is designed to deposit weld metal having a 20 to 80 per cent tungsten content, together with 0.5 to 0.6 per cent carbon.

Automatic Recorder-Controller for Testing

A device which makes possible the automatic control within narrow limits of rates of strain and stress application is announced by the Baldwin-Southwark Corp., Philadelphia, Pa. This device consists of several instruments, and is an automatic recorder and controller combined. It makes possible, during a test, the application of a constant load over a period of time, and it is also possible to produce strain-time and stress-time graphs, in addition to constant rate of strain and constant rate of stress. These instruments facilitate the interpretation and control of test results.



Welder Built for Tennessee Department of Highways.

Trade Literature

The Logansport Oxygen Co., Logansport, Ind., recently brought out a new wall card governing the safe rules and regulations covering the handling, storing and using of oxygen and acetylene cylinders.

"Properties of Toncan Iron" is the subject of a folder issued by the Republic Steel Corp., Massillon, Ohio. Use, fabrication, chemical analysis, physical constants, physical and chemical properties, heat treatment, etc., are discussed.

"Designed Piping" is the title of a pamphlet issued by the Taylor Forge & Pipe Works, P. O. Box 485, Chicago, Ill., giving test data bearing on the efficiency of fluid flow in piping with and without welding fittings, and relative strengths of such pipe installations.

"Hoover Dam" is the title of an illustrated 16-page booklet with cover issued by The Babcock & Wilcox Co., 85 Liberty St., New York, N. Y., showing views of the dam site, diversion tunnels, section of 30-ft. pipe, maps, and plan and sectional drawings of the dam and tunnels. Engineering data on the dam, power plant, tunnels, and steel pipes are included to give an idea of the immensity of the project.

News of the Industry

Florandin to Represent Harnischfeger in East

The Harnischfeger Corp., Milwaukee, has announced the appointment of the Florandin Equipment Co., 40 West 40th St., New York, N. Y., as its welder representative in the metropolitan district of New York and northern New Jersey. Mr. Florandin has been connected with the welding industry for more than twenty years and brings to his new interests an extensive background of experience in electric arc welding. The Harnischfeger organization is very optimistic regarding welder business in the Eastern territories.

Reduction in Prices of Welderlite Bulbs

Reductions in the prices of "Welderlite" bulbs have been announced by the McLean Welderlite Sales Co., 7133 S. Lincoln St., Chicago, Ill. These price reductions range from 25% to 40%, depending on the quantity ordered. These bulbs are built to operate from the low voltage of the welding circuit and are used in conjunction with the automatic "Welderlite," a convertible lamp for floor, bench, rack, or ceiling mounting. These bulbs give plenty of light for the welder, and automatically dim out when the arc is struck.

News in Brief

Rudolph Furrer, former chief engineer and director of research of the A. O. Smith Corp., manufacturers of welded pipe and pressure vessels, has joined the National Tube Co., to further extend this company's engineering and research work.

A company is soon to be formed in Southern California for marketing a new pipe-fabricating machine recently developed and patented by Carl Carlsen, of Green Bay, Wis. This machine, according to reports, forms and welds steel plates into pipe, and may be used either in the shop or field. Rolls are used instead of dies, and all pipe sizes may be manufactured.

Work has been started by the Ampco Engineering Co., of Dallas, Texas, on the installation of an 8x25-ft. bubble tower for the Arrow Producing & Refining Co., of Fort Worth. Fabrication is practically all by electric welding. This installation is to be at the company's refinery at Overton, Texas.

G. Raymond, chief engineer of Black, Sivalls & Bryson, Inc., Oklahoma City and Kansas City, recently moved his headquarters from Kansas City to Oklahoma City, where the company has a modern plant for fabricating gasoline plant and refinery equipment.

The Modern Machine Shop, Inc., 123 N. Hazel St., Danville, Ill., of which C. F. Carter is manager, is adding a complete metal-spray service. The sand-blasting chamber is being constructed entirely of steel plate suitably reinforced and completely welded.

Edwin Pratt Sons Co., Kankakee, Ill., structural and ornamental iron contractors, have purchased a 400-ampere G-E motor-driven, double-operator welding unit.

Empty carbide cans have been used to build an 18-ft. stove pipe, by Nygren & Barnes, Danville, Ill. The pipe was built by welding the cans end to end after their heads had been cut out.

The C. K. R. Manufacturing Co., Cleveland, Ohio, has purchased a complete Rego welding and cutting unit for their plant at Akron, Ind.

The Wayne Welding & Supply Co., Inc., 517 E. Wayne St., Ft. Wayne, Ind., have added a Metallizing unit to their shop equipment.

The Flour City Ornamental Iron Co., Minneapolis, Minn., have re-acquired all the business assets formerly held by the General Bronze Corp. of New York City, in Minneapolis.

M. E. Anderson, Nashua, Iowa, has purchased the blacksmith and welding shop at Basset, Iowa, of Fred Ebert, who had operated it for a period of more than 35 years.

Leamans Welding and Machine Co., Lafayette, Ind., have been appointed distributors for the Logansport Oxygen Company, Logansport, Ind.

C. L. Schrock, formerly of Indianapolis, Ind., has opened a job welding shop in conjunction with the City Blacksmith Shop located at 511 High St., Logansport, Ind. The shop is equipped with gas and are welding equipment.

The Cincinnati Manufacturing Co., Cincinnati, Ohio, have just purchased a 400-ampere motor-driven Lincoln arc welder.

The Welderaft Service & Supply Company, of Los Angeles, Calif., is now in its new location at 2440 East 14th St., having vacated some time ago its former location at 784 Kohler Street. C. J. Nyquist, owner and manager, has contributed much to the development of welding and is well known throughout the industry. He is an active and enthusiastic member of the Los Angeles section of the American Welding Society.

The Continental Distributing Co., of San Diego, Calif., has purchased the old abandoned plant of the Savage Tire Co. and will convert it into a brewery in the

near future. This plant will ultimately have a capacity of over 300,000 barrels per year, it is announced. The work of dismantling the old plant and remodeling, installing equipment, etc. will require a great amount of welding.

Roy McComas has announced intentions of erecting a new blacksmith, machine and welding shop to replace the structure in which he has done business for 40 years at Traer, Iowa.

After April 20th, the new address of Quasi-Arc Incorporated will be New Brunswick, N. J., P. O. Box 54, which is the location of the works in which Quasi-Arc electrodes will be manufactured in this country.

The Duro electrode holder made by the Churchward Engineering Co., New Haven, Conn., has been handled in Joliet, Ill., and surrounding territory by the Barrett Hardware Co. for the past year. Recent appointments of new representatives of the Churchward Engineering Company do not affect the status of the Barrett Hardware Co. as exclusive agents of the Duro Holders in the territory they

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BUSINESS OPPORTUNITIES

Sales Engineer or Agency Wanted—For exclusive representation of leading make of arc welders in both New York and Philadelphia territories. Permanent connection desired. Must have experience in welder field. Give complete information in confidential reply. Address Box 109, The Welding Engineer.

POSITIONS WANTED

Salesman—Young, aggressive, reasonably intelligent. Experienced in building up oxygen, acetylene and apparatus volume. Considerable field experience in addition to two years as assistant sales manager for large oxyacetylene corporation. Address Box 110, The Welding Engineer.

Combination Welder—15 years' experience in railroad shops, foundries and job shops, and on various production and maintenance jobs. Will go anywhere. O. A. Anderson, 1312 Herrick Ave., Racine, Wis.

Arc Welder—Experienced in all kinds of pipe welding, including pipe line construction, overhead and vertical. Expert with shielded arc. References. L. J. Mauer, 1624 S. Wisconsin St., Racine, Wis.

A-1 All-Type Welder—Have portable electric and acetylene outfit. Ten years' experience. Consider any reasonable offer, anywhere. James A. Ashman, General Delivery, Arroyo Grande, Calif.

Acetylene Welder—17 years' experience on pipe in field and shop; read blueprints; lay out work; 2 years in railroad repair shop. L. Formont, 90 Lincoln Ave., Merchantville, N. J.

Electric Welder—Eight years' experience, including boiler and pipe work. Address Box 111, The Welding Engineer.

Cast Iron Welding Rods

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serve, namely, Will, Kane, DuPage, LaSalle, Grundy, Kendall, Kankakee, Livingston, and Iroquois counties.

The West Kankakee Ornamental Iron Works, Kankakee, Ill., have added a new Rego welding outfit to their shop equipment. They recently received a contract to build an ornamental-iron porch railing which will be all-welded.

J. W. Galloway, Hoopeston, Ill., have added a complete valve grinding and seating service to their job welding shop. This equipment enables them to render complete service for the reconditioning of cylinder blocks in which they have welded cracked valve seats.

Otto Johnson & Son, Hoopeston, Ill., who operate a job welding shop, farm implement and hardware store, have added a complete machine shop to their business.

The Thompson Machine & Welding Co. was recently opened at 303 E. Van Buren St., Danville, Ill., by Ray L. Thompson. An Airco welding and cutting unit has been added and also a Lincoln arc welder powered with a Continental engine. The shop will specialize in welding, machine work, and boiler repairing, and will also do a blacksmithing business.

The Langenkamp Co., Indianapolis, Ind., recently purchased a 300-ampere Lincoln Stable Arc welder of the motor-generator type.

The Crawfordsville Radiator & Welding Co., Crawfordsville, Ind., of which George Wetzel is proprietor, has purchased a 200-ampere Hobart arc welder of the motor-driven type.

The Wallace Steel & Supply Company, 318 S. Third St., Lafayette, Ind., have been appointed distributor in their city for the Indiana Oxygen Co. of Indianapolis for their line of oxygen and acetylene and also welding apparatus and supplies.

The Procter and Gamble Co., Cincinnati, Ohio, have purchased their third 300-ampere Lincoln arc welder within the last few months.

The Liability Welding Co., Ft. Wayne, Ind., recently purchased a Pohlhamus Silent oil preheating torch having an operating capacity of 2½ gallons of kerosene per hour.

Montgomery Brothers, who operate a job welding shop in Marshall, Ill., recently installed a 300-ampere Hobart arc welder which was purchased from the Terre Haute Heavy Hardware Co., Terre Haute, Ind.

The Hollywood (Calif.) Portable Electric Welding Works, of 6310 Santa Monica Blvd., recently opened for business under the management of Walter Wilham, owner. Mr. Wilham will feature general automotive repair welding, including starter-teeth welding.

W. A. Estes, Jr., of Los Angeles, Calif., is erecting a building to house the welding department of his machine shop at 4017 Medford St. Mr. Estes recently built and assembled a motor-driven portable electric welding machine for use in his shop.

The Advance Welding Works, of Los Angeles, Calif., until recently located at 741 South San Pedro Ave., has moved to 749 East 15th St. Rudy Ostronik and Owen Temple, former partners in the concern, have dissolved partnership, Mr. Temple having recently assumed the sole ownership.

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